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MEDICAL AND SURGICAL REPORTS

OF

THE BOSTON CITY HOSPITAL.

Eighth Series.

EDITED BY

GEORGE B. SHATTUCK, M.D., W. T. COUNCILMAN, M.D.,
AND HERBERT L. BURRELL, M.D.

BOSTON:
PUBLISHED BY THE TRUSTEES.
1897.

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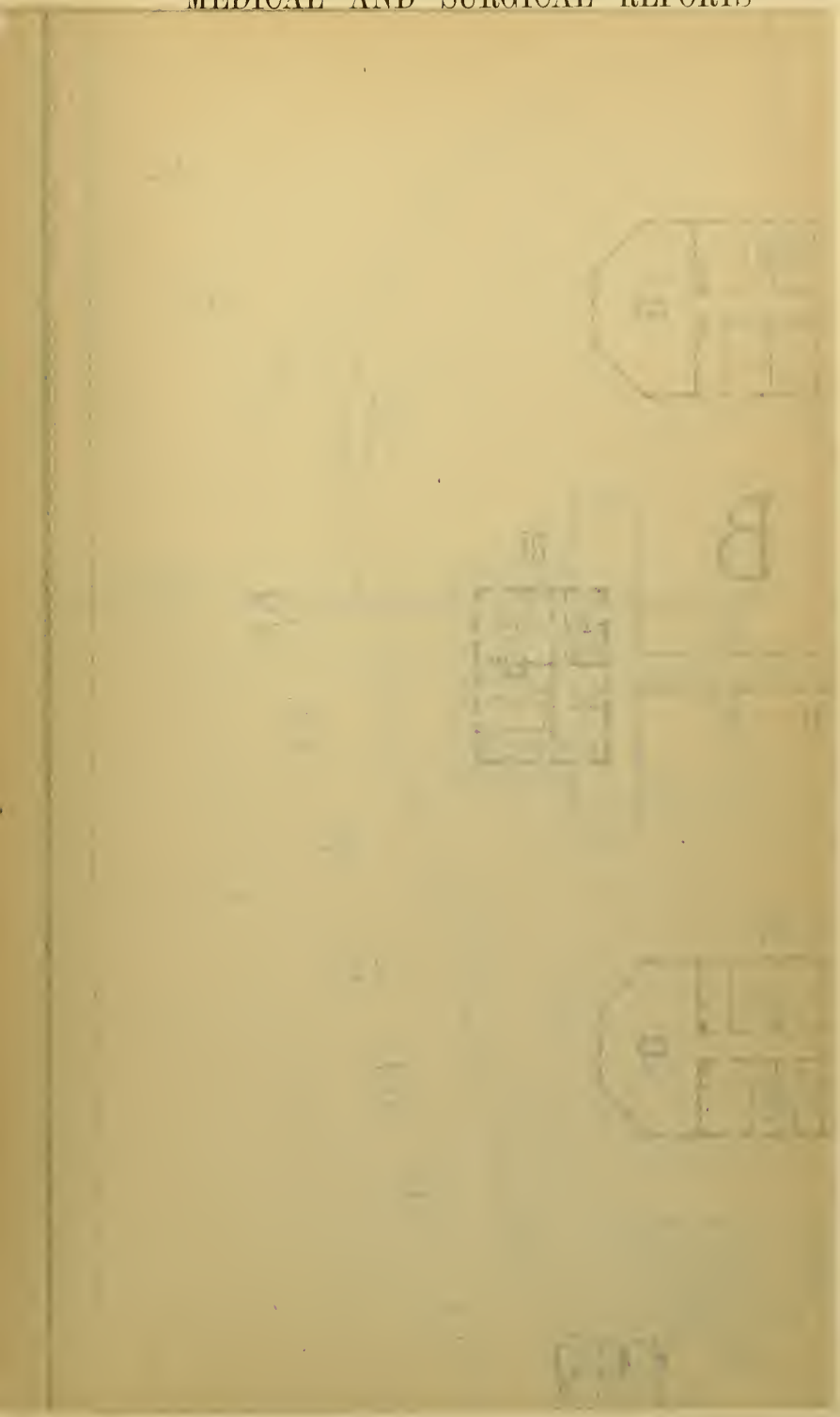


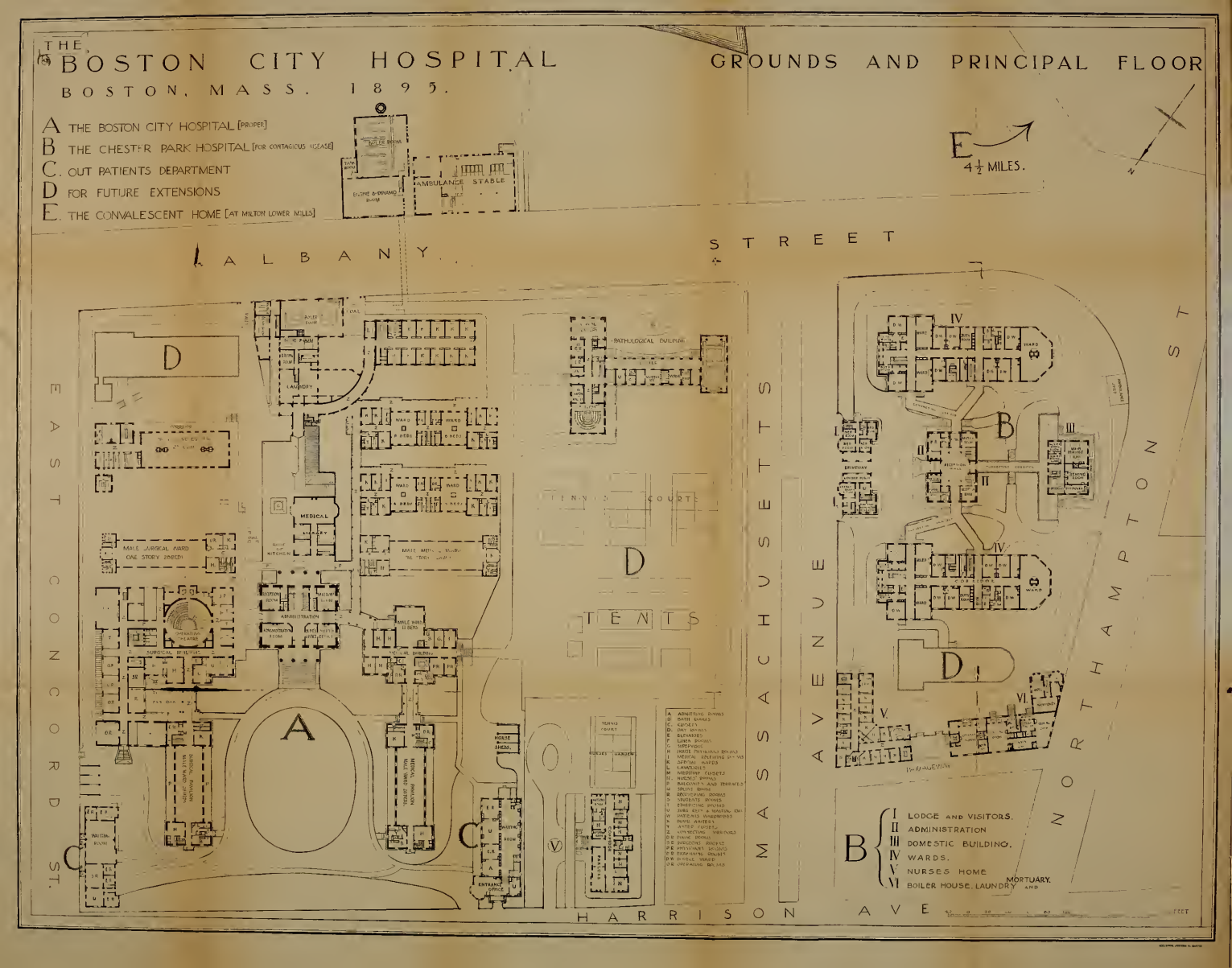
THE BOSTON CITY HOSPITAL

BOSTON, MASS. 1895.

GROUNDS AND PRINCIPAL FLOOR

A THE BOSTON CITY HOSPITAL [PROPER]
B THE CHESTER PARK HOSPITAL [FOR CONTAGIOUS DISEASE]
C. OUT PATIENTS DEPARTMENT
D FOR FUTURE EXTENSIONS
E. THE CONVALESCENT HOME [AT MILTON LOWER MILLS]

E 4½ MILES.



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PREFACE.

The eighth series of the Medical and Surgical Reports of the Boston City Hospital appears again as of late as an annual publication. The number of pages has been increased, but even with more space the editors have been forced to postpone to another year some contributions which they would gladly have included, among others a clinical and pathological statement of the cases of cerebro-spinal meningitis in the Hospital during a present epidemic. The anatomical and bacteriological study of acute and subacute nephritis, the statement of the treatment of diphtheria in the department for contagious diseases, the paper on the adaptation of X-rays to medical practice, though necessarily long, are valuable and timely contributions.

It is not strange that our report should grow as the Hospital grows. There are one hundred and fifty more beds than last year, the number of beds being now eight hundred and fifty-six, of which three hundred and one are in the contagious wards.

Since the publication of the last report the Hospital staff has lost by death Doctor W. C. B. Fifield, a member of the consulting board; Doctor Edward J. Forster, a visiting physician for diseases of women, and for a number of years the efficient secretary of the medical and surgical staff; and Doctor Edward Wigglesworth, for many years at the head of the department for diseases of the skin.

The Editors.

April, 1897.

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I.

THE TREATMENT OF DIPHTHERIA AT THE SOUTH DEPARTMENT OF THE BOSTON CITY HOSPITAL.

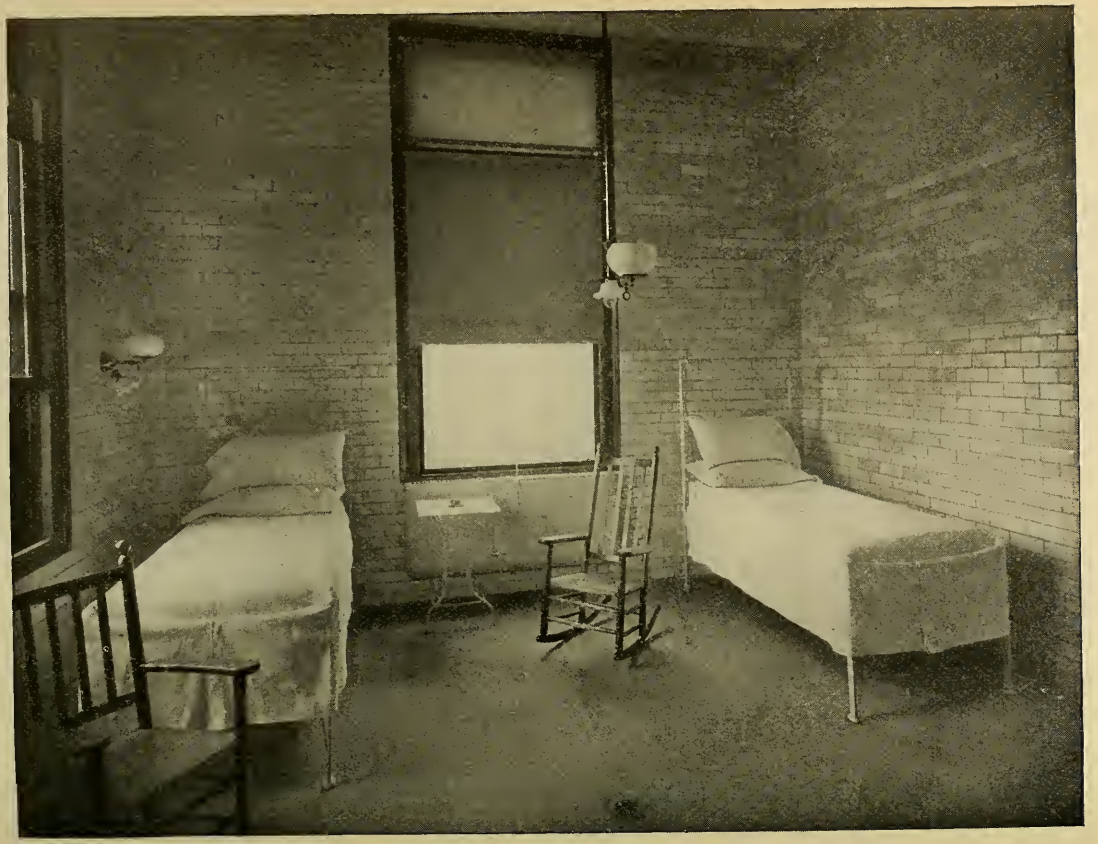
By John H. McCollom, M.D., *Resident Physician.*

The South Department of the Boston City Hospital devoted to the treatment of the three principal acute infectious diseases, namely, scarlet fever, diphtheria, and measles, was opened for the admission of patients on August 31, 1895. Previous to this time these diseases had been treated in two isolated wards situated in the group of buildings of the Boston City Hospital proper. The accommodations, however, had been found too limited, and in order to avoid crowding it was necessary to frequently refuse applications from patients suffering from these diseases. It was also found that the proximity of these wards to the hospital was a constant menace to the other patients and also to the employees. It was therefore decided, wisely, to establish a department for infectious diseases, which although an integral part of the hospital should be so isolated both by situation and administration that there could be no possible danger of these diseases being transmitted to either the patients or employees of the main hospital.

Owing to the fact that the site proposed for the erection of the new buildings was somewhat limited, it became necessary to so arrange these buildings that there should be as little communication between them as possible. There are seven buildings in this department: the Administration Building, the Gate Lodge, Domestic Building, Laundry Building, and the Home for Nurses, divided into two wings so that there can be no communication between nurses in charge of diphtheria patients and those having the charge of scarlet fever patients. The buildings for the patients are two two-story buildings each one hundred and sixty feet

THE BOSTON CITY HOSPITAL, — SOUTH DEPARTMENT. FOR INFECTIOUS DISEASES.
Rear View.

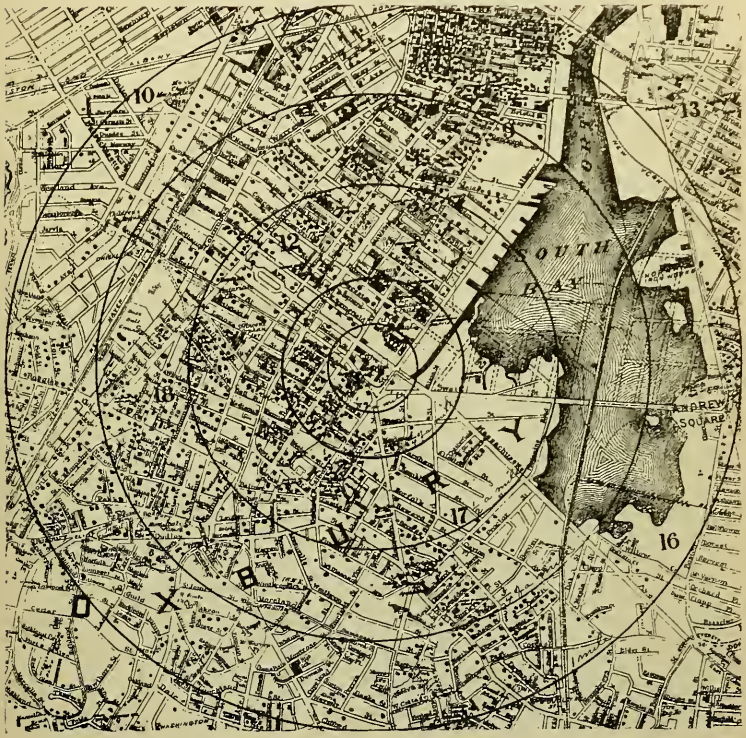
long and divided by open air transverse corridors, so that each floor can be separated into four completely isolated wards. In addition to this, each section is divided into small rooms capable of accommodating from four to seven patients, with the exception of the semi-octagonal wards at the southern end of each pavilion which accommodate, each, fifteen convalescent patients. There are also eight isolation wards the floors of which are of tarazzo pavement and the walls of glazed brick, so that these rooms can be thoroughly and effectively disinfected after the removal of patients. These wards are exposed to the open air on all four sides, therefore there can be no danger of the transmission of diseases from them. There is also a steam sterilizer on the premises for the disinfection of mattresses and all other articles that cannot be disinfected by boiling. All the garbage and refuse from the wards is burned in a crematory, so that there may be no danger to the public from these substances. The staff and all the employees reside on the premises in order that the chance of the hospital becoming a focus of disease may be reduced to a minimum. The capacity of the hospital is two hundred and fifty beds. The illustrations, pages 2, 4, 9, and 12, show a rear view of the hospital buildings, the semi-octagonal ward for convalescents, an isolation-room, and a transverse front view. The buildings are so arranged that one does not obstruct the sunlight from another. An abundance of sunlight plays such an important rôle in hospital construction that no hospital building should be considered worthy of the name that does not have plenty of sunlight. It been has said that hospitals for infectious diseases situated in a crowded locality become foci for the spread of disease, and while this may be true, if proper attention is not paid to disinfection and if the employees are permitted to reside outside the hospital, yet the history of the South Department for one year proves conclusively that a hospital for infectious diseases can be so conducted as not to be of the slightest danger to the community. It is a well-recognized fact that the germs of infectious diseases are not carried any very great distance through the open air. It is a fact accepted by all medical men that diphtheria is not transmitted through the air and that it



THE BOSTON CITY HOSPITAL, — SOUTH DEPARTMENT.

Probation or Isolating Ward.

requires close contact with the patient suffering from this disease to contract it. From the first of September, 1895, to the first of September, 1896, there were reported to the Board of Health of Boston 3,989 cases of diphtheria. The



Map showing the location of the cases of Diphtheria within one mile of the Hospital.

1st circle, $\frac{1}{8}$ of a mile	11 cases.
2d circle, $\frac{1}{4}$ of a mile	71 cases.
3d circle, $\frac{1}{2}$ of a mile	238 cases.
4th circle, $\frac{3}{4}$ of a mile	292 cases.
5th circle, 1 mile	423 cases.
Total	1,035 cases.

accompanying map will show the location of the cases that occurred within one mile of the hospital. The hospital has been taken as a centre and circles have been drawn with radii of an eighth of a mile, a quarter, a half, three-quarters, and a mile. Within the eighth of a mile radius and near the circumference of the circle eleven cases occurred. Of these

eleven cases six occurred in one house and could be directly traced to infection from one member of the family to the others. Although the source of infection in the five other cases could not be traced, yet from their situation it was evident that the disease could not have been contracted from the hospital. In the radius of a quarter of a mile 82 cases were reported, in a half mile radius 238, in the three-quarters of a mile radius 292, and in the mile radius 423, making a total of 1,035; the remaining 2,954 existing in other portions of the city, two, three, and in some instances five miles from the hospital. It might be said that naturally as the territory is increased the number of reported cases would also be increased, but the ratio of increase of the reported cases bears no relation to the increase of territory. A glance at the diagram should convince any one that the eleven cases occurring within an eighth of a mile from the hospital, but not in its immediate vicinity, could not be traced to infection from the hospital with any more reason than those occurring at greater distances. In short, nearly three times as many cases were reported more than a mile from the hospital as were reported within a mile.

It is generally conceded that the area of infection of scarlet fever is much greater than that of diphtheria. Investigations therefore of special hospitals as a source of disease are more satisfactorily conducted with scarlet fever as a basis. For the year ending September, 1896, 1,043 cases of scarlet fever were reported to the Board of Health. No case occurred within an eighth of a mile of the hospital; 68 cases within a quarter of a mile, and of these 68, 60 occurred in an eleemosynary institution in no way connected with the hospital; within half a mile 71 cases; 75 cases within three-quarters of a mile; and 72 cases within a mile; making a total of 286 cases within a mile of the hospital. The whole number reported to the Board of Health was 1,043, and therefore 757 cases occurred more than one mile from the hospital. The accompanying map, page 9, shows the location of the cases with reference to the hospital. It would seem as if these statistics would convince any unbiased observer of the truth of the statement that hospitals for infectious diseases when properly conducted are not

sources of danger to the residents in the immediate vicinity. It is very important, however, that all employees should reside in the hospital, and that they should wear clothing

Diagram showing the location of the cases of Scarlet Fever within one mile of the Hospital.

1st	circle, $\frac{1}{8}$ of a mile	0 cases.
2d	circle, $\frac{1}{4}$ of a mile	68 cases.
3d	circle, $\frac{1}{2}$ of a mile	71 cases.
4th	circle, $\frac{3}{4}$ of a mile	75 cases.
5th	circle, 1 mile	72 cases.
	Total	286 cases.

made of washable materials. It is also requisite that all garbage and refuse from the wards should be burned on the premises.

As showing that the bacilli of diphtheria do not diffuse themselves to any very great extent in a well-ventilated and cleanly hospital, cultures were made from the floors and from the ledges about the fire places. These cultures were placed in the incubator and stained and examined

at the pathological laboratory of the hospital. In cultures from room 5 there was found a diffuse growth on the blood serum, composed of a variety of bacilli, and a few cocci in groups. No bacilli of diphtheria were found. Cultures taken from room 7 showed a great variety of organisms, principally bacilli of different kinds, and sarcinæ. In room 9 there was a diffuse whitish growth composed of large spore-bearing bacilli and a great variety of other organisms. In cultures from room 17 a great variety of organisms was found. Cultures from rooms 27, 31, and 37 showed abundant growths of various organisms. In the culture from room 47, in addition to different varieties of bacilli, a few bacilli of diphtheria were found. In all of the seven rooms examined there was a greater or less number of patients in all stages of diphtheria and in only one instance did a culture show the presence of the bacilli of diphtheria. It has been claimed that flies may become a source of infection and therefore a few limited experiments were made bearing on this point. In one of the wards a fly, apparently feeding on the nasal discharge of a septic case of diphtheria, was captured and placed in a tube of serum. After the tube had been in the incubator for 24 hours, although there was an abundant growth on the surface of the culture medium, composed of a slender leptothrix and a great variety of bacilli, there were no bacilli of diphtheria found. In another ward where a fly was also found feeding on a nasal discharge that 24 hours previous had shown almost a pure growth of the bacilli of diphtheria, a similar result, so far as the bacilli of diphtheria is concerned, was obtained. Although these experiments are too limited in number to be conclusive, yet it is safe to presume that the danger from flies as carriers of infection has been over-estimated. A bacteriological examination was made of the air of three of the rooms in the following manner and with the following result. In each of these rooms where there were acute cases of diphtheria a flask with a capacity of 1,000 c.c. and containing 200 c.c. of bouillon, was fitted with a tight stopple through which passed two glass tubes, one of which passed nearly to the bottom of the flask, the other passed about two inches into the flask. The shorter tube was connected with an aspirator

THE BOSTON CITY HOSPITAL, — SOUTH DEPARTMENT.

Semi-octagonal Ward for Convalescents.

and the air from the ward was pumped through this flask for an hour. At the end of this time the flask was placed in the incubator for 20 hours, at the end of which time there was a very abundant growth in the bouillon of various bacteria. In the flask placed in room 7, cover glasses were made from this bouillon and the organisms found were the bacillus subtilis, the pneumococcus, and large bacilli. Cover glasses made from the flask placed in room 23 showed pneumococci, cocci, streptococci, and sarcinæ. On the cover glasses stained from the flask placed in room 31 were seen streptococci in very fine chains, large bacilli, and also the hay bacillus. In room 7 the flask was placed about four feet from the floor. In rooms 23 and 31 it was placed on the floor. Test tubes containing 10 c.c. of bouillon were inoculated from the flasks. At the end of 12 hours the bouillon in the test tubes became cloudy, and cover glasses made from these tubes at the end of 24 hours failed to detect the presence of the bacilli of diphtheria. Gelatin plate cultures and agar plate cultures were made from the bouillon in the flasks. Cover glasses and cultures were made from colonies having the slightest resemblance to those of the bacilli of diphtheria. Neither in the cover glasses made directly from the colonies nor in the cover glasses made from the bouillon inoculated from the colonies was the presence of the bacilli of diphtheria detected.

The study and treatment of diphtheria has assumed a new phase since the introduction of antitoxin, and while it is not claimed that antitoxin will cure every case of diphtheria, it is claimed, and the following statistics will prove, that the death-rate from this disease has been very much reduced by the use of the healing serum. It has been stated frequently, by the opponents of antitoxin, that the type of the disease has become milder, that many cases now recognized by a bacteriological examination as diphtheria would not have been so classed a few years ago, and therefore that all antitoxin statistics are unreliable. While this may be true to a certain limited extent, it is also true, as the experience of any one who has treated a large number of cases proves, that the course of the disease has been shortened, and that patients have recovered from severe attacks of diphtheria

who must have inevitably succumbed under the old methods of treatment. Baginsky, Director of the Emperor and Empress Frederick Children's Hospital, of Berlin, says emphatically it is absolutely untrue that since the introduction of the serum treatment diphtheria has assumed a less virulent type. On the other hand, he says that the most malignant forms have been treated by him successfully with the healing serum. He also says that for the six months ending June, 1896, the percentage of mortality, excluding moribund cases, was 8.22 as compared with a mortality of 40 to 50 per cent. a few years ago. Baginsky also says that between March 15, 1894, and March 15, 1895, the death-rate in his service in cases treated by antitoxin was 15.6 per cent., and that during the time when the supply of serum gave out, during the months of August and September, in the same hospital, the death-rate rose to 48.4 per cent. It has been noticed by many observers that during the warmer months diphtheria, as a rule, does not assume so virulent a type as during the colder months, and therefore the fact that in the former period when antitoxin was not used the death-rate was nearly three times as great as when it was used, seems to be a sufficient answer to the statement that antitoxin statistics are unreliable because based upon mild forms of the disease. Korte says that there was an increase from 33.1 per cent. when the serum was used to 53.8 per cent. when it was not used. Ganghofner noticed an increase from 12.7 per cent. with serum, to 53.2 per cent. without the serum. Heim found that the mortality rose to 65.6 per cent. without serum, as compared with 22 per cent. with serum. In an epidemic at Trieste the fatality rose to 50 per cent. when the supply of serum failed, as compared with 18.7 per cent. when it was used. As these statistics are based upon cases occurring in the same epidemics, the argument that antitoxin statistics are unreliable because based upon mild forms of diphtheria is untenable. In Boston from 1878 to 1894, the average death-rate of cases reported to the Board of Health was 30.7. The lowest death-rate was 26.44 and the highest was 35.7. As the majority of these cases were reported before bacteriological examinations were made, it is perfectly safe to

THE BOSTON CITY HOSPITAL, — SOUTH DEPARTMENT.

Transverse Front View.

assume that in some instances there may have been errors in diagnosis; but the errors would be so slight as not to materially affect the percentages. In the Boston City Hospital from February, 1891, to February, 1894, when antitoxin was not used, there were 1,062 cases of diphtheria treated, with 493 deaths, giving a percentage of 46. As this embraces a period of three years the type of the disease might change considerably. In the South Department of the Boston City Hospital for a period of 13 months from September, 1895, to October, 1896, there were 1,972 cases treated with antitoxin and of these 1,706 were discharged well; 266 died, giving a percentage of mortality of 13.4. If the deaths of the 70 patients who were admitted in a moribund condition are eliminated, it would bring the death-rate down to 10.3 per cent. If these statistics, that extend over a period of 13 months, a sufficient time for any variation in the type of the disease, are compared with the statistics of the Boston City Hospital proper, in pre-antitoxin days, the beneficial effects of antitoxin would seem to be clearly demonstrated. Again, it has been shown that the average death-rate for a period of 16 years, of mild and severe cases occurring in the city at large, was 30.7 per cent., and yet in hospital cases at the South Department the death-rate, exclusive of moribund cases, was 10.3. It must be borne in mind that in the majority of instances patients are not sent to a hospital unless they are seriously ill. Any intelligent observer who has watched cases of diphtheria must have noticed that what appears to be a mild case to-day assumes a serious aspect in the course of 24 hours, and any one who has carefully observed the action of antitoxin cannot but help being impressed with the fact that these apparently mild cases do not assume a grave aspect if antitoxin is administered early. No one who has intelligently observed diphtheria can ever speak with certainty at the commencement of the attack of the course of a so-called mild case of this disease. In the laryngeal cases antitoxin seems to be of very great use. Many cases with a certain amount of laryngeal obstruction are relieved without the necessity of either tracheotomy or intubation. If the laryngeal obstruction is sufficient to justify an operation, but

not to immediately imperatively demand it, the injection of antitoxin has in many instances in from 12 to 24 hours relieved the urgency of the symptoms and frequently large pieces of membrane have been coughed up. Dr. G. W. Gay, visiting surgeon at the Boston City Hospital, stated in 1885 that not a single case of pseudo-membranous laryngitis, which must be considered diphtheria, ever recovered at the hospital without operation. Dr. D. W. Cheever, senior visiting surgeon, made a similar remark. McKenzie gives the death-rate in cases of laryngeal stenosis without operation as 90 per cent. Although these cases are not stated to be diphtheria, yet it is safe to conclude that nearly all of them, in the light of our present knowledge, must have been diphtheria. The existence of laryngeal stenosis in a child, excepting, of course, when there is a tumor pressing upon the trachea, is rarely, if ever, caused except by the presence of a diphtheritic membrane. A streptococcus membrane is not sufficiently thick and tough to cause any marked difficulty with the breathing. The conclusion, therefore, that antitoxin, in certain instances, does relieve laryngeal stenosis caused by diphtheritic membrane seems to be correct. In addition to the use of antitoxin, some of the cases were placed under steam and others had calomel fumigation. While these measures relieved temporarily the urgency of the symptoms, the permanent relief was due to antitoxin, judging from the experience in pre-antitoxin days. In cases of intubation antitoxin has been of very great benefit. Waxham, of Chicago, in his monograph on intubation, states that of 150 cases collated by him previous to the use of antitoxin the percentage of recoveries was 27.33. O'Dwyer, of New York, the originator of intubation, reports in the "Medical Record" of Oct. 29, 1887, 50 cases, with 12 recoveries, giving a percentage of 24, and in the "New York Medical Journal" of Jan. 14, 1888, the same observer reports a second 50 cases, with 15 recoveries, giving a percentage of 30. As these cases occurred in private practice, it is reasonable to suppose that the operation was performed early, which is not always the case in hospital practice, because patients are sent to a hospital as a last resort. In the Boston City Hos-

pital, for the year ending Jan. 31, 1895, there were 89 intubations and 74 deaths, giving a percentage of recoveries of 17. These cases did not have antitoxin. In the South Department for the thirteen months ending Oct., 1896, there were 200 intubations where antitoxin was administered, with a percentage of recoveries of 46.5. If the percentage of recoveries in cases occurring in private practice where antitoxin was not used, is compared with that of hospital cases at the South Department where antitoxin was used, it will be seen that the percentage of recoveries in the hospital cases was considerably larger than that occurring in private practice. If hospital cases before the days of antitoxin are compared with hospital cases after the use of this agent, it will be seen that the percentage of recoveries has been increased from 17 to 46.5.

In regard to the relative merits of tracheotomy and intubation a few words may be said. It seems to me that intubation, in the majority of cases, is the better operation — first, because there is comparatively little shock; second, because there is no open wound to become infected; third, because the air in intubation enters the lungs through the natural channels, thereby diminishing the chance of bronchopneumonia, and lastly, because recovery is much more rapid after intubation than after tracheotomy, there being no granulating wound to heal. In adult life tracheotomy is perhaps the better operation. Bourdillat gives the following statistics of recoveries after tracheotomy by years: Under two years, 3 per cent.; between two and two and one-half years, 12 per cent.; two and one-half and three and one-half, 17 per cent.; three and one-half and four and one-half, 30 per cent.; four and one-half and five and one-half, 35 per cent.; over five years of age, 39.5 per cent. Waxham in his collection of 1,072 cases of intubation gives as the percentages of recoveries after intubation, by years, as follows: Under two years, 15.62 per cent.; between two and three years, 19.46; between three and four years, 30 per cent.; between four and five years, 32.65; between five and six years, 33.92; over six years, 43.33. It will be seen therefore that under two years of age the percentage of recoveries after intubation was five times as great as after trache-

otomy, and that in only one instance was the percentage of recoveries higher after tracheotomy than after intubation, and then the increase was very slight. It has been claimed that an intubed child could not take sufficient nourishment, that he suffered from the lack of liquids, and to obviate this condition of things various measures have been suggested, such as rectal alimentation, the use of soft solids for food, and by what is known as the Casselberry method of feeding, which consists in placing the child on its back and lowering the head so that the pharynx is on a lower plane than the larynx. When the child is placed in this position he can take a certain amount of food with comparative comfort. Nasal feeding, however, is by far the best method of introducing food into the stomach of an intubed child. It is not a painful procedure; it is not specially difficult to perform, and one has the satisfaction of knowing just how much food, how much stimulation, and what drugs are introduced into the stomach of the child. After the second or third introduction of the tube, as a rule, the child does not struggle and does not exhibit any indication of discomfort. The apparatus in use at the hospital consists of a soft rubber catheter in which is inserted a short glass tube which in turn is attached to a rubber tube and the rubber tube is connected with a glass funnel. The catheter having been well lubricated is slowly and carefully, without any force, passed through the anterior nares down into the œsophagus. The funnel is elevated and about two ounces of water is poured into it and then the requisite amount of milk and stimulants and whatever drug may be deemed advisable to administer, followed by an ounce or two of water. The catheter is then removed quickly but gently. If the catheter is removed slowly its passage may cause vomiting, therefore it is important to remove it quickly. The condition of intubed children fed in this way is very gratifying as compared with those fed in any other way. Nasal feeding is also of very great advantage in cases of post-diphtheritic palatal paralysis, and there is no doubt that lives have been saved by adopting this method of feeding when it was impossible for the child to take food in the natural way. Many cases might be cited in which death might have resulted either from inanition or

from pneumonia, caused by the introduction of food into the air passages, if this procedure had not been adopted.

An analysis of the 1,972 cases of diphtheria treated at the South Department shows that 1,074 had membrane on each tonsil. There were 1,030 discharged well, and 44 died. There was a recurrence of the membrane in 6 instances. Eruptions of urticaria and erythema appeared in 129 cases. Albuminuria was found to exist in 342 cases. Paralysis of the legs existed in 4 cases. Paralysis of the muscles of deglutition was noticed in 17 cases. There was epistaxis in 10 cases, and 3 died. Four patients had cardiac paralysis, all of whom recovered. In 6 instances joint pains, of greater or less severity, appeared. Eleven patients had spots of ecchymosis on the body and extremities. These spots of ecchymosis appearing in the course of diphtheria are an exceedingly grave symptom and have generally been supposed to be the forerunner of death, but of these 11 cases only 6 died. There were 3 cases of broncho-pneumonia. In 64 instances it was necessary to give a second dose of antitoxin because after the administration of the first dose the appearance of the membrane did not indicate that the serum had produced its characteristic action.

Much has been said regarding the accuracy of a bacteriological diagnosis, and it has been claimed that failure to obtain a positive result in cases of clinical diphtheria occurs very frequently. While owing to some error in technique, a negative result may be obtained, yet this so rarely occurs as not to be an important factor in invalidating the accuracy of this method of diagnosis. Of these 1,074 cases a positive culture was obtained in 1,008 of them, and of the remaining 66 the culture, although being negative at first, proved to be positive either at the second or third trial. The advantages of a cultural diagnosis are much greater in the milder cases, when it is impossible to say from the clinical appearances the exact nature of the disease of the throat.

There were 226 patients who had membrane on one tonsil, and who were admitted in the early stages of the disease, 3 of whom died. Of these 226, 72 had albuminuria; 15 had an eruption on the skin, in some instances

urticaria, in others erythema; 2 had palatal paralysis; 1 had epistaxis; 2 had cardiac manifestations; 2 had broncho-pneumonia; 2 had joint pains; 1 had a second attack of eruption on the skin. The report was negative in 21 instances at the first culture, but was positive subsequently, except in 2 cases. In 202 cases membrane covered each tonsil, the uvula, and the palate. These cases were admitted late in the disease, and many of them were practically moribund. Sixty-six died, giving a percentage of mortality of 32.6. This rate of fatality is only an additional argument in favor of the early administration of antitoxin. There can be no reasonable doubt, if these patients had received antitoxin at the earliest manifestation of the disease, that the lives of the majority of them might have been saved. Of these 202 patients, 88 had albuminuria; 1 had recurrence of the membrane; 32 had urticaria; 6 had paralysis of the legs and the arms; 29 had palatal paralysis; 8 had epistaxis, 5 of whom died; 8 had cardiac failure; 4 had joint pains; 9 had spots of ecchymosis, 7 of whom died; 2 had a second attack of urticaria; 2 had general paralysis, and in only 2 instances were there negative reports, due probably to the fact that the patients were so ill it was impossible to obtain satisfactory cultures. Fifty-five had two doses of the serum; 18 had three doses and 1 had four doses. Membrane was found on each tonsil and the uvula in 195 cases; 34 of these patients died. Albuminuria was found in 86 instances. The membrane re-formed in one instance. There were 21 cases of urticaria; 5 cases of paralysis of the legs and arms; 4 patients had epistaxis, 3 of whom died; 5 had failure of the action of the heart; 2 had joint pains; 2 patients had spots of ecchymosis, 1 of whom died; 1 had a second attack of urticaria; there were 10 cases of palatal paralysis; 1 had general paralysis; the knee jerk was found to be absent in 5 cases; the failure to obtain a positive result in the first culture occurred in 11 instances. Two doses of antitoxin were given to 35 of these patients; 4 had three doses and 1 had four doses. In one instance the patient inoculated his eye with the discharge from the nose and a diphtheritic membrane formed on the conjunctiva. The action of antitoxin

on this membrane in the eye was very satisfactory, for in the course of 24 hours the membrane commenced to disappear, and in 48 hours the eye had improved so much in appearance that there was no longer any cause for anxiety. This patient was discharged well with each of his eyes in a good condition. Membrane was found on one tonsil, uvula, and palate in 5 instances; none of these patients died. Albuminuria was found in 2 cases.

Of the 200 intubations 147 had membrane on each tonsil, and in 53 cases no membrane was found. The percentage of recoveries in these 200 cases, as has been before stated, was 46.5. Of the 147 intubed patients who had membrane on each tonsil 41 had albuminuria; 26 had urticaria; 5 had palatal paralysis; 1 who had epistaxis died; 10 had broncho-pneumonia; 1 had joint pains; 3 had a second attack of urticaria; 4 had general paralysis; and in 42 the first culture was positive. Two doses of antitoxin were given in 12 instances. Of the 53 intubed patients who had no membrane visible, 8 had albuminuria; 9 had urticaria; 1 had palatal paralysis; 1 had joint pains, and in 1 there was a second attack of urticaria; 2 had broncho-pneumonia; 1 had two doses of antitoxin. The first culture taken was positive in 10 instances. Of the 38 laryngeal cases in which there was membrane on each tonsil, but in which the laryngeal stenosis was presumably relieved by antitoxin and calomel fumigation or steam, 22 had albuminuria; 9 had urticaria, and the initial culture was positive in 25 cases. Of these 38 cases 2 died, but the cause of death in neither instance was due to laryngeal stenosis, but was due to broncho-pneumonia in one instance, and cardiac failure in the other. Of the 22 cases of laryngeal diphtheria with marked dyspnœa, in which no membrane was discovered, and in which the symptoms were relieved by antitoxin, 13 had albuminuria; 3 had urticaria; 1 had cardiac failure and recovered; 1 had joint pains. In this class of cases no death occurred.

The number of deaths after tracheotomy, but not due to the operation, was 10. Of these 10, 3 died from extension of the membrane; 4 from shock, and the remainder from broncho-pneumonia.

To sum up the 1,972 cases, 34 per cent. had albuminuria;

12.3 per cent. had urticaria, and the percentage of cases in which it was necessary to give two doses of antitoxin was 8.9. In the laryngeal cases it is the exception, so far as the presence of the bacilli of diphtheria is concerned, that a positive culture is obtained unless there is membrane visible, and yet in this class of cases 77 were positive of the 210. The failure to obtain a positive result in the bacteriological examination of cases of laryngeal diphtheria is due to two causes: first, the membrane in certain instances is situated so far down in the larynx that it is impossible to reach it with the wire or swab; and second, the condition of the patient is frequently such that attempts to make a careful inoculation are not justifiable. It is unwise in cases of this description to wait for the result of the culture before giving antitoxin and before performing intubation or tracheotomy. Of the 1,702 non-laryngeal cases the culture was negative in 100 instances, or 5.8 per cent. If the unavoidable errors in technique, which must necessarily occur in the manipulations required in bacteriology are taken into account, it would seem that the low percentage of negative results is a most convincing argument in favor of the accuracy of a bacteriological diagnosis. Much has been said regarding the existence in the throats, of healthy individuals, of an organism morphologically similar to the bacillus of diphtheria. The writer a short time ago made an examination of 130 non-diphtheritic throats, and in no instance was an organism found that in any way resembled the bacillus of diphtheria. It has also been claimed that the bacilli of diphtheria may be found in cultures taken from the throats of persons who although not ill have been exposed to diphtheria. While it is perfectly true that in certain rare instances this may occur, yet cultures taken from the throats of twenty-five nurses on duty in the diphtheria wards of the South Department showed the presence of the bacillus of diphtheria in only one instance.

Regarding the injurious effects of antitoxin, concerning which a great deal has been said, the positive assertion can be made that of the 3,000 injections given at the South Department in no instance was there any serious result that could in any way be attributed to the use of this agent. While it is perfectly true that in certain instances annoying

symptoms have occurred after the use of antitoxin, yet this is no more an argument against its administration than is the nausea and vomiting that follows the administration of ether an argument against the use of ether. The advantages derived from the use of antitoxin, so far as the personal observation of cases and study of statistics published by competent observers all over the world are concerned, show conclusively that at last we have arrived at some method of treatment of diphtheria that is at least a great advance over former methods. It is not to be supposed that everybody will accept the statement that the anti-diphtheritic serum is a remedial agent of great value any more than everybody will believe in the protective power of vaccination. But the fact remains, and is capable of positive demonstration, that there is a greater percentage of recoveries with the use of antitoxin than by any other method of treatment. It has been stated that albuminuria is caused by the use of antitoxin, but the observers who have made these statements have lost sight of the fact that albuminuria very frequently occurs in the course of diphtheria, and they also have not appreciated the well-recognized fact that the toxin of diphtheria may cause albuminuria, as is proved by the condition of the kidneys of guinea pigs that have died from injections of pure cultures of the diphtheria bacilli. In an article on diphtheritic paralysis by E. W. Goodale, M.D., Medical Superintendent at the Eastern Hospital, Homerton, England, published in the "Brain" for 1895, the following statement regarding albuminuria in cases of diphtheritic paralysis is made. Albuminuria was found in 110 cases out of 125, which gives a percentage of 88. The statement is also made in the same article that out of 1,071 cases of diphtheria treated, 30 per cent. had albuminuria. As the cases on which these figures are based occurred in 1892 and 1893 it is safe to presume that antitoxin was not used. Of the 1,972 patients treated with antitoxin at the South Department 674, or 34.1 per cent., had albuminuria, which proves that antitoxin does not increase the frequency of albuminuria to any appreciable extent. In 173 cases the urine was examined before and after the administration of antitoxin. Of these 173 cases it was found that in 99 instances albumin

was absent, both before and after the administration of antitoxin, which was without doubt due to the fact that the healing serum was administered before the diphtheritic membrane had increased sufficiently to generate toxin enough to cause albuminuria. In 33 cases the albumin was about the same; in 25 the albumin was diminished; which seems a sufficient argument to the claim that antitoxin causes albuminuria. In 16 cases the albumin was increased, but not to a sufficient extent to cause any special anxiety. As these were severe cases the conclusion that the albuminuria was caused by the toxin of diphtheria, and not by the healing serum, is justifiable.

Eruptions on the skin of different varieties have been observed in 244 instances. These eruptions can be classified as urticaria, erythema, a papular eruption and an ecchymotic eruption which must be distinguished from the spots of ecchymosis occurring as an early symptom in severe attacks of diphtheria; a punctiform eruption resembling scarlet fever and an eruption resembling that of measles. The first four eruptions are sufficiently characteristic not to present any very great difficulties in diagnosis, but the last two so closely resemble eruptions of scarlet fever and measles that the most careful examination is required to make a definite diagnosis, and in some instances it is absolutely impossible to make a positive diagnosis from the appearance of the eruption. In the scarlatinal form of eruption the absence of vomiting; a normal temperature; no hardness of the palms of the hands or tips of the fingers; the fact that the papillæ of the tongue are not enlarged; the absence of any eruption in the throat, are the cardinal points on which the diagnosis has been decided. In some of these cases there has been a slight desquamation, but it has not been the characteristic desquamation of scarlet fever. In the measles-like eruption the diagnosis has been based upon its transient character; that there was no rise in temperature; that the eruption appeared first on the extremities; that there was no coryza; that there was no cough; no eruption in the mouth; no eruption behind the ears. Notwithstanding, however, the most careful examination of the patients there were some doubtful cases in which a positive diag-

nosis was impossible. It is perfectly well known that in septic cases of diphtheria, an eruption very closely resembling that of scarlet fever not infrequently occurs, and it is also possible that in some instances an eruption of this character may have been attributed to antitoxin, when its cause was the poison of diphtheria. In no instance have these eruptions been a source of great annoyance to the patient, and the discomfort caused by them has been relieved by appropriate remedies. In a small number of cases, joint pains resembling articular rheumatism have been noticed. These joint pains, although a source of considerable discomfort to the patient, have not been sufficient to cause any great amount of anxiety, and have been followed by no serious results. In a very few instances, abscesses have occurred after the injection of antitoxin, but the number is so small that it is hardly worthy of consideration, being no greater than would follow a large number of subcutaneous injections of morphine. In some cases it was evident that the injection of antitoxin was only the excitement of a predisposing condition of the patient. As illustrating this point, the following cases may be of interest. Two sisters with severe attacks of diphtheria were injected with the same specimen of antitoxin; one had a large cervical abscess from which a pure culture of streptococci was taken; the other had a small abscess at the point of inoculation, which also gave a pure growth of streptococci. The injection of antitoxin had certainly nothing to do with the cervical abscess, and it is at least doubtful if the injection was the direct and immediate cause of the second abscess It is a significant fact that pure cultures of streptococci have been obtained from nearly all of the cervical abscesses at the hospital occurring in the course of diphtheria. Pain and redness at the point of inoculation have been observed in quite a number of cases, but these symptoms, as a rule, have disappeared in the course of from 12 to 24 hours. In no instance has the pain been so severe as to interfere with sleep, or to require the administration of morphia.

The dose of antitoxin has been variously stated by different observers. The amount, however, given must depend upon the number of antitoxin units that the specimen used

contains. As an initial dose, from 1,000 to 2,000 units, depending upon the age ot the patient, should be given. If there is not a marked improvement in the appearance of the throat, and in the general condition of the patient, at the end of 24 hours, a second dose should be given. At the end of the second 24 hours, if the membrane has not commenced to roll up at the edges, if the swelling of the cervical glands has not diminished, if there is a profuse nasal discharge, with a septic odor, a third dose should be given, and in certain cases, a fourth dose may be required. Of the 1,972 cases treated at the hospital, 1,776 received one dose, 170 two doses, 24 three doses, and 2 received four doses. The two patients who received four doses died, but their condition was hopeless from the very first.

The method employed by Behring and Ehrlich in testing the strength of antitoxin is the one now generally in use in Germany. Ehrlich, however, the director of the German Imperial Testing Bureau, is employed in developing a new method of testing the strength of the serum which, it is said, will be somewhat simpler than the present one. In the Boston "Medical and Surgical Journal" of Dec. 17, 1896, Behring's method of testing the serum is thus described: "Diphtheria toxin is injected subcutaneously into a series of guinea pigs to determine accurately the smallest quantity of toxin which is fatal to the guinea pig. When this has been determined the toxin becomes the test toxin. A given quantity of serum to be standardized is mixed with ten times the minimum fatal dose of the test toxin, and injected subcutaneously into guinea pigs of nearly the same weight as those used in standardizing the toxin. If no local œdema nor infiltration appears, if, in other words, the guinea pig is completely protected, the quantity of serum used contains one-tenth of an antitoxin unit.

"This is best illustrated by an example: The test toxin has been standardized and found of such strength that 0.039 of a c.c. is the minimum fatal dose. The serum to be tested is diluted with sterile normal salt solution until 1 c.c. contains $0.0016\frac{2}{3}$ c.c. of serum. The serum and 0.39 c.c. of toxin are mixed and injected subcutaneously. If the guinea pig remains permanently well and shows no œdema at the

place of injection, 0.0016⅔ c.c. contains at least one-tenth of an antitoxin unit. One c.c. would contain at least 60 units, that is, enough serum to completely protect 600 guinea pigs from ten times the fatal dose of toxin. The antitoxic unit may thus be defined as being contained in ten times that quantity of any given serum which is required to neutralize ten times the minimum fatal dose of diphtheria toxin when mixed with the latter and injected subcutaneously into a guinea pig."

Prof. H. C. Ernst employs Roux's method in testing the antitoxin with which he supplies the hospital. This method is described by him as follows: "A normal toxin is one of such a strength that .1 c.c. injected subcutaneously in a guinea pig weighing 500 grammes kills the animal in forty-eight hours. In other words, kills 5,000 times its weight of guinea pig. We call a normal antitoxin a serum of such a strength that .1 c.c. injected at the same time subcutaneously in a 500 gramme guinea pig with 1 c.c. (ten times the fatal dose) of normal toxin produces no effect. In other words, protects 50,000 times its weight of guinea pig, and is therefore of a strength of 1 to 50,000. This is a serum that for practical purposes is marked dose 10 c.c., or approximately sufficient to protect 100 pounds. When we find the serum tested in the same way of a strength of 1 to 100,000 or over, we mark it dose 5 c.c., an amount approximately sufficient to protect the same weight."

Many places have been selected for the site of the injection — the outer aspect of the thigh, the abdomen, the back, and the upper part of the thorax near the posterior axillary line. After trying these different places, experience has shown that the last-mentioned situation is the most desirable, because here the tissues are lax, there is no danger of entering a vein, and the patient can lie on the back or on one side without bringing any pressure on the inoculated place. If an abscess forms there is no danger of burrowing of pus as might be the case in the thigh and back. The technique of the injection is as follows: The parts are thoroughly sterilized by washing with a solution of corrosive sublimate; a portion of the skin is pinched up and the needle plunged deeply into the cellular tissues.

The puncture made by the needle is sealed by sterilized gauze and collodion. It is very important that the needle and syringe should be carefully sterilized by boiling. It is advisable to pour the antitoxin through sterilized gauze into the barrel of the syringe rather than to attempt to draw it through the needle. There are many different kinds of syringes in the market. Williams' syringe, which has an asbestos packing and is made of glass, is the one in use at the hospital, and it has proved to be well adapted for its purpose. Lüer's syringe, which has a ground-glass piston accurately fitted, is a very satisfactory instrument. It makes very little difference what kind of a syringe is used if the different parts are made of materials that can be sterilized by heat without injury. A comparatively small needle should always be used.

Antitoxin has no influence on the later symptoms of diphtheria caused by the action of the toxin, such as paralysis, cardiac failure, and nerve degeneration, but it does have a marked effect in preventing the formation of toxin and the consequent appearance of these symptoms. In Pepper's "Theory and Practice of Medicine," published in 1893, the percentage of post-diphtheritic paralysis in a large number of cases is given as 40. In the Homerton Hospital, England, of 1,071 cases treated without antitoxin paralysis occurred 125 times, giving a percentage of 12. Of the 1,972 cases treated with antitoxin at the South Department paralysis occurred in about 115 instances, 5.8 per cent. It should be said that in some instances paralysis may have occurred after discharge from the hospital, but as an allowance has been made for this possible error, it can be assumed that these figures are approximately correct. The conclusion, therefore, that antitoxin does not cause paralysis, as has been asserted, is justifiable.

Cardiac failure, due either to a fatty degeneration of the heart muscle or to a disordered innervation, is a frequent cause of death during apparent convalescence from diphtheria. A study of the cases of diphtheria at the South Department proves that this condition is not so common since antitoxin has been used as it was before the use of this agent. Of the 1,972 cases treated cardiac failure was the

cause of death in 52 instances, giving a percentage of 2.6. In 20 instances recovery took place after the appearance of this symptom.

The degeneration of the pneumogastric nerve, causing irregular action of the heart, a change in the rhythm of respiration and persistent vomiting, is, in certain instances, a cause of death. The number of cases, however, in which an autopsy has been obtained has been very few. In only one case has the nerve been examined microscopically, but judging from a careful study of the symptoms of the 52 fatal cases it is safe to conclude that degeneration of the pneumogastric nerve is the cause of death when it occurs during convalescence in a large proportion of cases. The study of this condition offers a very fruitful field for investigation, but the impossibility of obtaining permission for autopsies has prevented a thorough study of this subject.

The history of the following case in which marked degeneration of the pneumogastric nerve was found may be of interest. G. B. was admitted to the hospital in August, 1895. He had one dose of antitoxin, and the case progressed favorably until the 12th of September when he complained of pain in the stomach and had a weak pulse. He passed a fairly comfortable night, but in the morning had persistent nausea and vomiting. He was restless, with a very rapid and feeble pulse. After the administration of brandy and strychnia subcutaneously he seemed to rally a little, but four hours afterwards he became cyanotic, the pulse became weaker, and he died about 24 hours after the commencement of the attack. The record of the autopsy made by Dr. Stokes is as follows: "Heart: organ enlarged, especially right auricle, which was filled with dark clotted blood. On opening left ventricle several round organized pea-sized thrombi were found surrounding small chordæ tendineæ. The cusps of the aortic valve were thickened and somewhat retracted and along their line of closures there were a number of pinpoint grayish vegetations. The walls of each ventricle were thickened. Lungs: leathery and tough to feel, and on section rather dark-red with much yellow, frothy serum extruding on pressure. Bronchi contained the same frothy material, and the mucous membrane was reddened. Pharynx and

tonsils were entirely free from fibrinous or other inflammations. Liver: veins on under surface at edge very much dilated and of a bright-blue color. On section the organ was rather cloudy with occasional pale and yellow areas. Gall bladder normal. Spleen: enlarged and rather soft, pulp increased. Malpighian bodies enlarged. Kidneys: on section circulatory markings unusually prominent. The stomach, pancreas, intestines, bladder, and rectum were normal. The mesentery glands were enlarged and reddened. Anatomical diagnosis: acute vegetative endocarditis; chronic fibrinous endocarditis of aortic valve; insufficiency of aortic valve; general dilatation and hypertrophy of heart; chronic passive congestion of liver, kidneys, and spleen; chronic passive congestion of lungs; acute mesenteric lymphatic hyperplasia." This case was of particular interest because the patient was apparently convalescent and yet suddenly became collapsed and died in a very short time. The pneumogastric nerve was removed and examined by Dr. J. J. Thomas who gives the following account of the microscopical appearances. "Sections of the pneumogastric nerve stained by Marchi's method showed, both in cross and longitudinal sections, marked degenerations of the nerve sheaths. The nerve sheath of the fibres most affected are entirely replaced by drops of fat. Others showed here and there drops of fat, and in other places brownish discoloration. In the fibres most affected no axis cylinders could be made out. The others show in places swollen and beaded axis cylinders. The intensely degenerated fibres constitute approximately one-third of the nerve."

The history of the following case in which no autopsy could be obtained, but from the symptoms it is safe to conclude that death was caused by degeneration of the pneumogastric nerve, may be of interest. A. B., 25 years of age, was admitted to the South Department, January 11, 1896. He had a very extensive membrane on the tonsils extending to the uvula. The heart sounds were feeble. He received two doses of antitoxin at an interval of 24 hours. The membrane disappeared very slowly. The case progressed favorably until the 25th of January when he had an attack of heart failure and angina, which seemed to be relieved by

stimulation. The case then progressed fairly well until the 16th of May, when there was a second attack of heart failure on which stimulation of different kinds had no effect. The patient died four hours after the commencement of this second attack of heart failure and 66 days from the commencement of his illness. The long duration of this case, the marked paralysis of the extremities, and the failure of the action of the heart, indicate that there must have been a general degeneration of all the nerves, particularly the pneumogastric.

The history of a third case in which all the symptoms pointed to a degeneration of the pneumogastric nerve, yet from the fact that the patient recovered would seem to prove that there could have been no very great amount of actual degeneration, is also interesting. A. B., 6 years of age, was admitted January 6, 1896, with extensive membrane covering each tonsil and the uvula. She received two doses of antitoxin, one on entrance and one 48 hours later. After the second dose the condition of the throat improved very rapidly. On the 11th of February the patient was up and about the ward. On the 20th she had an attack of collapse, was almost pulseless, the respirations were irregular, and there was persistent vomiting. Stimulation by the rectum and subcutaneously was administered, and after a few hours the patient commenced to rally. As the patient was unable to swallow, food and stimulants were given by the nasal tube for fourteen days, at the end of which time the child was able to take food by the mouth. She gradually improved until the 24th of March when she was discharged well. This case is of special interest from the similarity of the symptoms as compared with those of the first and second cases reported.

In addition to the use of antitoxin, stimulation has been freely administered by the mouth when possible, and by the rectum if necessary. No special drugs have been administered, except where the peculiar condition of the patient seemed to demand them. In the majority of cases irrigation with a hot saline solution has been the topical application to the throat. In other cases a weak solution of corrosive sublimate, of chlorinated soda, and of electrozone have

been used. No caustics nor irritating substances have been applied to the throat. It is a well-recognized fact that the less you irritate the throat of a patient suffering from diphtheria the better for him, and therefore these mild applications have been used.

From the study of these 1,972 cases of diphtheria treated at the South Department the following conclusions are justifiable:

First. That antitoxin is a remedial agent of very great value in the treatment of diphtheria.

Second. That the healing serum does not cause albuminuria.

Third. That its use does not predispose to paralysis.

Fourth. That in the laryngeal cases of diphtheria the benefit derived from its use is as great, if not greater, than in the non-laryngeal cases.

Fifth. That the statement which has been made that antitoxin statistics, because based on mild attacks of the disease, are unreliable, is incorrect.

II.

AN ANATOMICAL AND BACTERIOLOGICAL STUDY OF FORTY-NINE CASES OF ACUTE AND SUBACUTE NEPHRITIS WITH SPECIAL REFERENCE TO THE GLOMERULAR LESIONS.

By W. T. Councilman, M.D.

There are some peculiar features in the pathology of the kidney which are due to its anatomical structure. It may be considered a double glandular organ. The glomerulus has the structure of a true gland, with capillary wall, basement membrane, and differentiated epithelium. The tubule leading out from the glomerulus may be considered partly as an excretory duct for that glandular structure, but it has glandular functions of its own as well, and adds various substances to the secretion of the glomerulus. The glomerulus is exceedingly complicated in its structure, especially in the arrangement of its vessels. How complicated are the vascular structure and the relation of the epithelium to the vessels can only be appreciated by one who has made prolonged and minute study of the glomerulus. The character of the epithelium in the tubules and the calibre of the lumen vary in different parts of their course. Glomeruli and tubules are held together by a small amount of reticular connective tissue. There is a dense membrane propria back of the epithelium.

Nearly all of the blood which is distributed in the kidney first passes through the vessels of the glomerulus, which, uniting into a single vessel on leaving this, again breaks up into capillaries. From this it can be seen that any lesion of the glomerulus which interferes in any way with the circulation of the blood in its vessels must exert a marked effect on the nutrition and function of the other parts. Of the lymphatics and the lymph circulation in the kidney little or nothing is known. It is probable that there are lymph

spaces around the vessels and in the interstitial tissue which gradually unite to form definite vessels which pass out of the organ along the veins and arteries.

In the interstitial tissue there are few cells except those belonging to the capillaries. On a well injected kidney, or in one in which the vessels are naturally injected with blood, it is almost impossible to find in the intertubular tissue of the cortex nuclei which are not connected with the vessels. Around the larger arteries and veins in the zone just above the pyramids[1] there is a more definite connective tissue, and in this considerable numbers of cells may be found in the normal kidney. They greatly increase in number in almost all pathological conditions. The cells are round, there is little or no protoplasm around the nucleus, they stain as the lymphoid cells of the blood and lymphatic glands, and when they proliferate they give rise to cells of the same character. It is not unlikely that they represent small masses of lymphoid tissue analogous to that around the small bronchi in the lungs. I have never found any free leucocytes in the interstitial tissue or in the tubules of the normal kidney.

There is considerable power of regeneration in the kidney, which becomes less the older the individual. In the normal kidney it is probable that in the ordinary processes of wear and tear not only portions of epithelial cells which are destroyed form again from the old, but new cells are formed. By poisoning animals with small doses of cantharadin, and killing them after varying intervals, numerous nuclear figures, particularly in the collecting tubules, are found. It is not probable that in the adult human kidney portions which are wholly destroyed can be regenerated. No evidence that this is the case can be seen about infarctions. The glomeruli are incapable of complete regeneration when destroyed. In the hypertrophy of the kidney which follows extirpation of one organ the glomeruli enlarge often to double the normal size, but there is no new formation of

[1] I shall refer to this as the intermediate zone. While it is true that the cortex immediately adjoins the pyramids, there seems to be a certain propriety in separately distinguishing the lower portion of the cortex and the adjoining pyramid. In this area there are found the greater part of the tubules of Henle and the large vessels, both arteries and veins. Pathological conditions may be found exclusively or best marked in this area.

complete glomeruli. Hypertrophy of the remaining glomeruli may be found in kidneys in which there has been extensive destruction, and the same is probably true of the tubules.

In order that the kidney may retain its normal structure and function a number of conditions are necessary. The blood must enter the kidney in the proper amount and under the normal variations of pressure. The circulation of the blood in the kidney must not be impaired. Disease of the glomeruli may interfere with or almost stop the circulation in other parts of the organ.

There must not be any impediment to the exit of the blood. The small veins in the kidneys are numerous. The blood pressure within them is low, and passive congestion is felt to a greater degree in the kidney than in most organs. Degenerative lesions of the epithelium are produced not only by the presence of the retained venous blood, but the direct pressure exerted on the epithelium by the enlarged veins probably has some effect.

A free exit must be given to the products of secretion. The ureter is thin; it pursues a long course and is little protected from pressure. There are a series of pathological conditions which can produce an impediment to the outflow of urine and increased pressure in the tubules. This will lead to various alterations of structure. In all of these conditions the cause and the character of the lesions are easily understood.

The character of the blood coming to the kidney must be normal. The various diseases of the kidney, due to alterations in the character of the blood, are the most numerous, the most serious, and their pathology is the most difficult. In a consideration of these lesions it is obvious that we can divide them into classes. Insoluble, injurious substances may be brought to the kidney by the blood and deposited in various places in its tissue. Such insoluble substances will produce lesions in the tissue immediately around them, and will be focal in character. There is difference again in the insoluble substances, in that they may be inert, acting merely mechanically, as is seen in the production of an infarction by a bland embolus, or they may be infectious

living organisms. The bacteria, occluding a large vessel, may, in addition to their direct action on the surrounding tissue, act mechanically, producing an infarction.

It is obvious that bacteria can enter into the renal tissue only by the blood or by the urinary passages. It was formerly thought possible to decide, from the character of the pathological process and the situation of the bacteria, in which way they had entered the tissue. If by the blood, they would be found in a blood vessel, which would form the centre of a focus, and if they reached the kidney by the urinary passages they would be found in the tubules. A combination of both ways of infection may be found in the same organ. Bacteria can easily pass from the blood vessels into the tubules, and they must do so when they grow into the surrounding tissue. They will then be washed down the course of the tubules and develop lesions when they meet with favorable conditions for their growth. In many cases it is impossible to decide whether a focus of suppuration has started in a tubule or in a blood-vessel. Examples of such bacterial lesions are seen in the various purulent affections of the kidney and in tuberculosis. Focal lesions of the kidney may also be produced by pathological conditions of the circulation which affect only certain vascular territories. The more or less focal lesions found in arterio-sclerosis are examples. Many of the lesions of the senile kidney may also be referred to local disturbances in the blood supply.

There is more difficulty in the study and classifications of those diseases of kidney which are due to the conveyance to the kidney of injurious substances in a soluble form. Generally such substances affect all parts of the kidney and produce lesions of almost equal degrees of severity. Both classes of lesions — the focal and the diffuse — may be found in the same kidney. In cases of severe staphylococcus infection, focal lesions may be met with around bacterial emboli or thrombi, and, in addition, there may be diffuse lesions which are due to the presence in the blood of soluble chemical substances, which are produced by the bacteria, either in some other focus in the body or in the kidney. It is perfectly true that in a number of infectious

diseases, notably in diphtheria and typhoid fever, focal lesions in various organs, as in the liver, spleen, and lymph glands, may be produced by the influence of soluble substances in the blood. The explanation of the production of such focal lesions is not clear, and they are rarely met with in the kidney.

It must not be supposed that all parts of the kidney are equally affected by these soluble substances. In studying the degenerations of the kidney we find in certain cases that the convoluted tubules are alone affected, in others the collecting tubules or the tubules of Henle. Certain substances have a definite injurious action on one or another of the constituents of the kidneys, but all similar tissues are affected to almost the same degree.

In any attempt to classify these diffuse lesions of the kidneys we find difficulty in the beginning in the choice of a word which shall apply to the whole process. Bright (1827) regarded all the conditions of the kidney associated with albuminuria as most probably representing three stages of the same disease. He further regarded them as probably inflammatory in character. Rayer (1840) divided the lesions described by Bright into six different forms, and separated the albuminuria due to venous hyperæmia from the essential diseases of the kidney. He regarded the whole process as inflammatory in character. Reinhardt, in 1850, was the first to make a careful histological study of the lesions in the kidney, using the more improved methods available at that time. He regarded the process as essentially inflammatory, and considered the different anatomical appearances found as representing different stages of one and the same disease, the small shrunken granular kidney being the last stage in the process. Reinhardt did not separate the purulent, distinctly inflammatory affections of the kidney from the diffuse. Frerichs (1851) concluded as Reinhardt, that the pathological processes in the kidney represented a single disease, and the differences in the anatomical appearances were due to different stages of the process. This view as to the unity of the diffuse pathological processes in the kidneys was opposed in England by Wilkes (1850), and in Germany by Bartels (1875). Wilkes concluded from

clinical observations that the large swollen white kidney did not pass into the small hard, that the lesions in the two conditions were absolutely different and due to different causes. Bartels called especial attention to the differences in the clinical course of the disease marked by the large white kidney as distinguished from the small red; dropsy being a prominent feature in the first, and usually absent in the last. Virchow's work on inflammation (1852) served to direct observation to the part played by the epithelial constituents, and introduced the term parenchymatous inflammation. He saw the chief inflammatory lesions not in the exudation and the vascular apparatus, but in changes in the epithelial cells. Beer (1859) described the connective tissue of the kidney. He recognized its presence not only in the pyramids but in the cortex, and introduced the term "interstitial nephritis" to describe that form of disease in which the lesions are chiefly seated in the interstitial tissue. The diseases of the blood vessels of the kidney were studied by Ziegler (1879), who recognized a special form of disease — arterio-sclerotic nephritis — due to these vascular lesions. Charcot, partly from clinical, partly from pathological anatomical observations, distinguished three different forms of nephritis. The first form was characterized clinically by a rapid course, diminution in the amount of urine, large amount of albumen and dropsy, and anatomically by the large white kidney. The second, clinically, by a chronic course, increase in the secretion of urine, small amount of albumen, and anatomically by the small red contracted kidney. The third form was the amyloid kidney. Weigert (1879) published a celebrated article on Bright's disease, in which he separated the diseases of the kidneys into those which were solely degenerative and those which were inflammatory. In this article he denies the possibility of inflammatory lesions confined to the parenchyma of an organ or of primary interstitial lesions. There may be degenerative lesions of the kidney of so slight a character that they do not cause either exudation from the vessels or proliferation of the connective tissue, but interstitial changes are always accompanied and preceded by lesions of the parenchymatous tissue. For him the whole

process which was regarded as Bright's disease was a diffuse nephritis in which he distinguished different forms. The views of Weigert have been accepted by most of the German clinicians. It is difficult to find a single term which fits these diffuse lesions of the kidney. We have used the term nephritis, but it must be understood that the lesions, generally speaking, are not wholly inflammatory. While inflammatory exudation in some form is present in almost every case the majority of the lesions are not inflammatory.

For the present the classification of these diffuse diseases of the kidney must be founded on the character of the anatomical lesions. A classification on an ætiological basis is the most scientific and the simplest. We know nothing of the ætiology of these diseases. Various forms of disease of other organs, particularly of the heart, are often associated with them, and bacteriological investigation has frequently shown, in many cases, the presence of certain organisms in the kidneys. In most cases the bacteria are found in some other lesion and in the blood, and their presence in the kidneys is but a part of a general septicæmia. Moreover, the same conditions in the kidneys may be found associated with various organisms, and the same organism may be associated with widely different anatomical lesions. Nor is there anything in these lesions to show that they are produced by the direct action of bacteria. All of the lesions of the kidney which can be traced to the influence of bacteria acting directly on the tissue are focal, and appear in the immediate sphere of the bacteria. From the diffuseness of the lesions, from their affecting all parts of the kidney, it would seem evident that they must be due to certain substances in solution in the blood. We know that such chemical substances are produced by bacteria, and their presence in the blood can produce various lesions, mainly degenerative in character, in the kidneys. The lesions, however, may be of another character. Morse has shown that the continued injection of the sterile filtrate of virulent cultures of the staphylococcus aureus into the blood will produce, not only degeneration of the epithelium, but hyperplasia of the interstitial tissue. In cases of staphylococcus infection we have seen in the same kidney local lesions around

the foci of bacteria, and diffuse lesions affecting all parts of the tissue. We know that in almost all of the infectious diseases degeneration of various degrees of intensity may be found in the kidneys. Although it is probable that the chemical substances produced by bacteria may play an important role in the production of renal disease, their importance may be overestimated. Even when we find renal disease associated with bacterial infection localized elsewhere, the relation between the two may be the other way. The renal disease may be the primary condition, and the bacterial infection may be due to some alteration in the character of the blood which renders the tissues more prone to infection. Chemical substances may be produced in the alimentary canal or by imperfect action of some one or other organ in the body which may exert a deleterious action on the kidneys.

Nor can a classification on a clinical basis be made. The presence or absence of dropsy in different cases cannot lead to a differentiation of the nature of renal disease. The dropsy which may be said to be of renal origin, and of the pathology of which we know little, cannot be clearly separated from dropsy due to secondary changes in the blood or circulatory organs. The chemical and microscopic examination of the urine, important as it is, does not give any sure information as to the character of the lesions. Little attention is often given to the quantity of urine passed by the patient. What is needed on the clinical side are more numerous and more thorough clinical observations. Careful chemical examinations of the blood and urine might throw some light on the subject.

When we speak of these lesions as diffuse, we do not mean that all parts of the kidney are equally affected. The study of the degenerations and the effect of poisons has shown that in some cases the main stress falls on the convoluted tubules, in others on the collecting tubules, or on the loops of Henle. All parts of the kidney are equally exposed to the injurious action of chemical substances, but all may not be equally susceptible. With slight differences in the intensity of the lesions due to conditions which we do not understand, and which may represent increased or dimin-

ished local resistance, all susceptible tissues will be affected. In the same way, in the more serious lesions of the kidney, we find that in one case the glomeruli are principally affected, and although the lesions in the glomeruli may be accompanied by lesions chiefly degenerative of the tubular epithelium, these lesions may be in part or wholly secondary to the lesions of the glomeruli. In other cases again, there are lesions in the connective tissue consisting in active proliferation of the cells contained in this. This acute hyperplasia of the connective tissue, though accompanied by degenerative changes in the epithelium, cannot be considered as secondary to such changes.

An anatomical classification can never be so sharp and definite as one based on ætiology. In the anatomical classification there often occur mixed forms. One affection may have another grafted on it, — an acute glomerular affection may be added to a chronic arterio-sclerotic change. The anatomical classification must be based on the character of the lesions as determined by histological examination. Although the microscopic lesions are accompanied by more or less distinct alterations in the gross appearance of the kidneys, yet the connection is not sufficiently definite to enable us to determine absolutely by these gross appearances the one form of lesion from the other.

1. *Acute diffuse nephritis.*

"A." *Acute degenerative nephritis.* — In this are included degenerative lesions of the epithelium, embracing cloudy swelling, hyaline, fatty, and dropsical degeneration, and often complete necrosis, without lesions other than degenerative, in the glomeruli or in the interstitial tissue. This occurs chiefly in infectious diseases, in jaundice, and in anæmia, and as the result of the action of certain poisons. The kidney is slightly swollen or unchanged in size, rather paler, and more opaque on section; the markings may be obscure or more prominent than normal. There is often albuminous exudation in the glomerular capsules and in the tubules.

"B." *Acute glomerular nephritis.* — The essential changes consist in acute lesions in the glomeruli. There may be acute proliferation of the endothelium of the vascular tufts,

hyaline and fibrinous thrombi in the vessels, accumulation of leucocytes in the vessels, degeneration of the vessel wall, etc. These changes in the vascular tufts of the glomerulus can take place with or without changes in the capsular epithelium. The changes in the capsular epithelium consist in degeneration and proliferation. The capsular space may contain an albuminous, hemorrhagic, or fibrinous exudation. The changes in the vascular tuft and in the capsule are so frequently combined in various degrees that they cannot be separated into two sub-classes. The glomerular lesions are accompanied by degeneration of the tubular epithelium, necrosis, and exfoliation. Often there is dilatation of the tubules, œdema, and cellular proliferation of the intertubular tissue. There may be more or less hemorrhage in tubules. Occurs in infectious diseases, notably in acute endocarditis, measles, and diphtheria, or as an independent affection. The kidney is usually increased in size. Capsule easily strips off, surface pinkish, mottled, with points of ecchymosis; on section, cortex is wide, rather paler, and more opaque, markings obscure, glomeruli pale, enlarged, and prominent. Pyramids often congested. The tissue moist and may pit on pressure. While these appearances are usually marked, lesions of the glomeruli may be found with but little macroscopic change in the kidney.

"C." *Acute hemorrhagic nephritis.* — The essential change consists in hemorrhage in the tissue combined with degeneration of epithelium. The hemorrhage is chiefly found in the capsules of the glomeruli and in the tubules. The degenerative lesions may be extensive and lead to necrosis and exfoliation. Œdema, hemorrhage, and some cellular infiltration is often found in the intertubular tissue. The kidney is enlarged, hemorrhages are found in the capsule, the surface dark-red, with numerous ecchymoses. On section the cortex is swollen and sprinkled with dots and streaks of ecchymosis. Only three cases of this were found in my series.

"D." *Acute interstitial non-suppurative nephritis.* — The essential lesion consists in acute proliferation of the cells in the intertubular tissue. The proliferation takes place mainly from the vascular endothelium. The cells lie

within and without the vessels. They are large and similar to the epitheloid cells of young granulation tissue. They are found chiefly in the intermediate zone of the kidney between the pyramids and the cortex. In the cortex they are both generally diffused and in areas chiefly around the glomeruli. There is more or less degeneration and necrosis of the tubules, affecting chiefly those in the areas of cellular infiltration. Leucocytes in small numbers may be found in the intertubular tissue among the other cells, in the degenerated epithelium, and in the lumen of the tubules. The glomeruli are not affected. Occurs in acute infectious diseases, notably in diphtheria and scarlet fever. The kidney is large, pale, somewhat mottled: on section moist, opaque, markings obscure; milky fluid can be pressed from it.

2. *Subacute glomerular nephritis.* — The essential lesions are in the glomeruli. They consist in swelling and nuclear increase in the vascular tufts and obliteration of the vessels by hyaline degeneration both of the cells and the vascular walls. These changes in the tufts are often combined with proliferation and desquamation of the capsular epithelium, with connective tissue in growth. There is extensive degeneration, necrosis, and desquamation of the tubular epithelium. The intertubular tissue is the seat of œdema and connective tissue formation. There is often a previous history of exposure to cold, or of an infectious disease, and the affection may occur in rheumatism or endocarditis. The kidney is enlarged, the capsule may cling slightly to the surface; surface pale or slightly mottled. On section, cortex increased in width, pale, opaque, markings obscure, glomeruli pale, consistency increased. There are gradual transitions between this and the acute and chronic glomerular nephropathy.

3. *Chronic diffuse nephritis.*

"A." *Chronic glomerular nephritis.* — The essential lesions are in the glomeruli. They consist in extensive hyaline degeneration of tufts and of entire glomeruli and obliteration of capillaries. Every transition may be seen between these glomerular lesions and those in the subacute. There may be some increase in the capsular epithelium and connective tissue formation within the capsule. The tubu-

lar epithelium shows extensive degeneration and destruction. Entire tubules are destroyed, often being represented by the thickened irregular membrana propria. There is a general and diffuse increase of the connective tissue affecting almost equally all parts of the kidney. This condition is usually found as an independent affection, or may be combined with acute infections of various sorts, where is often a history which points to a previous acute or subacute affection. The kidney may be slightly larger than normal, of normal size, or considerably smaller. The capsule is often adherent, the surface even, not granular, pale. On section, cortex varies in width, may be quite small, is opaque, whitish, the markings obscure, the glomeruli not visible or pale, and the consistency of the tissue is greatly increased.

"B." *Chronic arterio-sclerotic nephritis.* — The essential lesions are in the arteries and consist in those changes which are known as arterio-sclerosis. There is degeneration of the epithelium of the tubules, with more or less complete destruction. The degeneration takes place slowly, and at any given time sections may show only a slight degree. Atrophic changes in the epithelium are common. The lesions may affect almost equally all parts of the kidney, or appear in areas corresponding to the vascular territories of those arteries which are most affected. There is a general increase in the connective tissue, though large areas of tubules may be found with no increased tissue between them. The lesions are never so diffuse as in the glomerular form. This condition of the kidney is found accompanying a general arterio-sclerosis affecting all the arteries of the body, or the vascular lesions may be most marked in the renal arteries. The kidney varies in size, it may be slightly larger, or of normal size, but is usually very much smaller. The capsule may or may not be adherent. The surface is more or less irregular and granular. The color red, often cyanotic. On section the cortex may be much diminished in size, of a dark-red color, the markings obscure, the glomeruli injected. The arteries in the intermediate portion are evident and often project above the cut surface. The pyramids show venous congestion. The con-

sistency of the kidney is greatly increased. The lesions are due to a combination of causes, — to the diminution in the blood supply, to the impairment of the function of the vessels by the destruction of the muscular coat, and to the accompanying venous congestion. Most of the cases of contracted kidney belong to this class.

"C." *Chronic degenerative and interstitial nephritis.* — To this class belong those cases of contracted granular kidney which occur without primary arterial lesions. It is difficult to give a name to the condition, for there is no single change which predominates. Degeneration, atrophy, and destruction of the epithelium in various degrees are found. There is a general increase in the connective tissue more diffuse than in the arterio-sclerotic nephropathy, but not so diffuse as in the chronic glomerular form. The increase in the connective tissue is most intense where the degeneration of the epithelium is most marked. Lines of connective tissue extend to the surface and by their contraction produce depressions. Very minor degrees of change, which may consist in small areas of cellular infiltration with hyperplasia of the connective tissue extending down from the capsule, are very commonly found. The essential lesion seems to be a slow degeneration of the epithelium, followed by connective tissue hyperplasia. The macroscopic appearances of the kidney vary extremely, following the different degrees of the lesions. The gross and microscopic condition may be complicated by lesions of another character.

4. *Senile nephritis.* — In the senile kidney the chief lesions are those due to disease of the vessels. These vascular lesions are accompanied by impairment in the power of regeneration. Previous lesions of the kidney, even though slight in character, may gradually make their influence felt in impairing the resistance of the tissue. The epithelial lesions may consist chiefly in atrophy. Macroscopically the kidney is usually more or less injected and atrophied.

5. *Amyloid nephritis.* — In the amyloid nephritis, as the name implies, the characteristic lesion is the amyloid infiltration of the blood-vessels. This may occur alone,

and may produce certain lesions of the tissue, or it may accompany any of the other forms of nephropathy. When amyloid infiltration affects the glomeruli alone lesions closely resembling those in other forms of glomerular nephropathy may be produced.

In this paper I shall give the results of the study of forty-nine cases of nephritis. They embrace acute, subacute, and chronic glomerular, acute interstitial, and acute hemorrhagic forms. Where possible, cultures have been made both from the kidneys and other organs, and the organisms determined. It is to be regretted that the clinical histories of the cases given are unsatisfactory. In many cases it was impossible to learn anything relating to the kidneys. The histological methods used in the investigation consisted in fresh frozen sections, and sections after various methods of hardening. A great deal of importance should be attached to the study of frozen sections, because only in this way can the presence and degree of fatty degeneration be distinguished. The recognition of fatty degeneration is more easy by this method than after hardening the tissues in preparations containing osmic acid. Boiling small pieces of the tissue and cutting the sections after freezing has also given good results. The method of hardening consisted in use of Muller's fluid, alcohol, Flemming's solution, corrosive sublimate, Zenker's fluid, formaline, and formaline combined with Muller's fluid, as recently recommended by Orth. In many cases the vessels were injected with the hardening solution. No one method of hardening is capable of universal application. In general, the best results were obtained from Zenker's fluid and from alcohol. Sections were cut after embedding in celloidin or paraffine, and stained in a variety of ways. Hæmatoxylin followed by eosin usually proved the most satisfactory. After hardening in Flemming's solution, safranine gave the most satisfactory stain. In all cases the tissues examined were from early autopsies and in good condition.

Acute, subacute, and chronic glomerular nephritis. — The glomerular lesions in diseases of the kidney were recognized by the earlier investigators, but it is only of late that the importance of the part they play has been appreciated.

Virchow (Gesammelte Abhandlungen) describes the increase in cells in the glomerulus, and gives a figure illustrating the condition. Forster (Pathol. Anatomie, 1863) has described the increase of cells of the capillaries and thickening of the wall in some cases, and in others proliferation and desquamation of the epithelial cells of the capsule. Klebs (Path. Anatomie, 1876) was the first to study these changes of the glomeruli more closely. He describes in the kidney of scarlet fever proliferation and degeneration of the capsular epithelium. The cells become enlarged and polygonal and fill up the capsular space. After their removal numbers of cells in the glomerulus are seen, which come from a proliferation of the cells of the connective tissue between the vessels of the glomerulus. Langhans (Virch. Arch., 76) studied more closely the origin of the cells in the glomeruli. He considers proliferation of the capsular epithelium as the first change in the glomerulus, and the masses of cells so produced may compress the vessels. In this article he mentions an increase in cells in the capillaries, and in a later article (Virch. Arch., 99) he describes more fully the capillary lesions. These lesions consist in proliferation of the capillary endothelium leading to the accumulation of cells within the capillaries, and the formation of a protoplasmic network which completely occludes the vessels. Hansemann (Virch. Arch., 110) describes the cells in the glomerulus as lying between the capillaries and due to proliferation of the connective tissue. Hyaline thrombi in the vessels of the glomeruli were described by V. Kahlden (Zeiglers Beitrage, XV.). Ribbert (Nephritis and Albuminuria, Bonn, 1881) speaks of the importance of the glomerular lesions in all cases of nephritis. He found them not only in acute scarlatinal cases, but in all cases, both subacute and chronic. Welch (Trans. of Asso. American Physicians, 1886) describes the glomerular lesions observed in the human kidney, as well as those produced experimentally in white rats by the injection of cantharadin. He proposes the term desquamative glomerulitis to describe those cases characterized by proliferation of the capsular epithelium with accumulation of cells in the capsules, and intracapillary glomerulitis to describe those cases in which the

accumulation of cells inside of the capillaries is the chief lesion.

ACUTE GLOMERULAR NEPHRITIS.

Case I. — Man, age 50. Syphilitic infection fourteen years previously. No symptoms referable to it. October 1, confined to bed for two weeks with rheumatism. November 2, seen for the first time by physician. Temperature at this time, 102; pulse, 90. No albumen in urine. For the week following the condition remained about the same: temperature, 101 in the morning, 103 in the evening. Spleen was considerably enlarged. The second week was a repetition of the first. The third week the temperature diminished somewhat, running from 100 in the morning to 101 in the evening. No albumen up to this time. On November 22 urine examined and one-eighth per cent. albumen found. From this time he failed rapidly. November 24, much worse, appetite diminished, sweat profusely at this time, and continued to do so until death. November 25, pulse 108; action of heart tumultuous. Albumen increased in amount, specific gravity 1010. Amount of urine passed during twenty-four hours amounted to only 150 cc. On November 26 marked œdema of lungs. Urine had greatly diminished and he passed none in fourteen hours, then passed only 60 cc. During afternoon and evening of November 27 he became markedly dyspnœic, and complained of pain in region of heart. Death, November 28. Autopsy on the 29th.

Slight œdema of ankles. No œdema elsewhere. Lungs congested and œdematous. In the lower lobe of right lung several foci of broncho-pneumonia. Numerous infarctions in both lungs.

Heart, large; weight, 500 grmms. Acute ulcerative endocarditis of aortic pulmonary valves.

Both kidneys of same size and general appearance. Combined weight, 520 grmms. Capsule thin, easily stripped off. Cortex of a pale, pinkish-gray, and somewhat mottled. There are small whitish areas about 1 mm. in diameter, and between them small red points and areas of injection. On section, the average thickness of cortex, 1 cm. Markings

of cortex obscure. The cortex on section presents the same appearance as surface beneath capsule. Small opaque whitish areas and puncti-form hemorrhages found throughout it. The entire kidney appears moist and œdematous. Pits slightly on pressure. Malpighian bodies are enlarged. They project above the cut surface, and appear as pale, glistening points. Pyramids are swollen, and the striations are coarser than normal. Pelvis is thickened, œdematous, and sprinkled

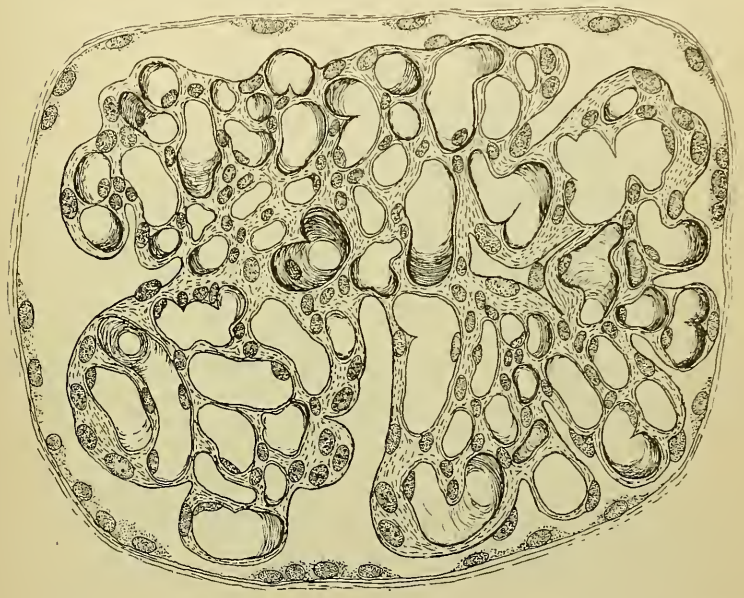


Fig. I. — Section through a small portion of a glomerulus, the vessels of which are somewhat distended by passive congestion. 1-12 oil immersion camera lucida drawing.

with points of ecchymoses. On fresh examination of kidney — frozen section — there is found a rather diffuse fatty degeneration. Corresponding to the white areas there is a more extensive degeneration, the fat in rather large droplets. Sections of the boiled kidney showed only traces of exudation within the capsular space. (Fig. I.)

Sections of the kidney were examined after hardening in corrosive sublimate, alcohol, and Flemming's solution. With low power the large size and numbers of the nuclei in the glomeruli are conspicuous. The glomerular space is completely filled up, and in some cases a portion of the

glomerulus projects into the tube leading from the space. There is no general increase in the capsular epithelium. The capillaries of the glomeruli are greatly dilated, their walls conspicuous and refractive. They contain cells and a large amount of detritis. The abundant nuclei of the glomerulus are almost all contained in the capillaries. (Fig. II.) Only a few of the nuclei belong to the polynuclear leucocytes. Most of them are round or oval, and similar to the nuclei found in the proliferating connective tissue. Among these nuclei are a number of large oval vesicular

Fig. II.—Single glomerular vessels from Case I. In the upper figure the cells lie loosely within the vessels, and in the lower they are adherent to the wall. 1-12 immersion camera.

nuclei, similar to those in the epithelium of the glomerulus. In many cases it is impossible to say whether these nuclei are within or without the vessels. In general there is a small amount of protoplasm around the nuclei in the capillaries. Most of the protoplasm lies loosely and indefinitely in the capillary tube, in some cases forming more or less of a network as Langhans has described. In some cases large irregular laminæ or long protoplasmic masses, containing nuclei, lie in the capillaries. In some of the capillaries considerable nuclear detritis is found. In sections hardened in Flemming's fat granules are found frequently, both in the epithelium covering the capillaries, and in the protoplasmic

masses within them. Mixed with the nuclei and protoplasmic masses in the capillaries are a few red corpuscles. Many of the glomeruli contain none at all. The epithelium of the convoluted tubules is thin, granular, and atrophic. In places it is cast off and lies loosely in the lumen of the tubes. Some of the tubules are filled with granular detritis, among which brightly stained particles of nuclear detritis may be found, but in no part of the kidney are there any distinct hyaline casts. (Fig. III.) Everywhere the

Fig. III. — Section from kidney, Case I., under low power, showing enlarged glomeruli and œdema of intertubular tissue. Obj. A. Zeiss.

tubules are widely separated from one another. There is no general increase in the connective tissue, the separation of the tubules being apparently due to œdema. There is a loose reticular-looking tissue, containing comparatively wide spaces around the capillaries between the tubules. Here and there in the section there are areas of small cell infiltration. Most of the cells in these areas are leucocytes. They are not only in the tissue between the tubules, but in many cases in the epithelium and within the tubules. These areas of cellular infiltration correspond to the areas of greatest degeneration and necrosis of epithelium. In a few

places there is an increase in the cells between the tubules of a different character from leucocytes. Here, both within the capillaries and between the tubules, there are larger cells with a large granular nucleus, with a varying amount of definite granular protoplasm around them. Many of these nuclei are similar to those in the glomerular capillaries.

The most careful search for micro-organisms in the kidneys hardened in alcohol failed to reveal them. At the autopsy cultures were made from the various organs. In the kidney and liver a few colonies of colon bacilli were found. Cultures from the heart and lungs were negative. A small portion of one of the diseased valves was removed and placed beneath the skin of a rabbit. A large fibrinous exudation extending from the point of inoculation almost entirely around the body of the animal developed at this point. The animal was killed at the end of two weeks. Typical pneumococci were obtained both in culture and on microscopic examination from the abscess. Sections of the heart showed numerous typical pneumococci within the pus cells.

This case is interesting as being one of typical pneumococcus infection of the heart. From the clinical history we can form some idea of the duration of the kidney lesions. The urine only showed albumen on the examination made five days before death, and from this time the amount of urine greatly decreased.

Case II. — Man, age 42 years. Entered hospital December 2, 1893. Five years before entering had rheumatism in hands, elbows, and knees, with swelling. Present illness began five days before entry into hospital, with pain and swelling of hands and knees. The swelling gradually disappeared during his stay at the hospital, and at death was only slightly perceptible. No general œdema or anasarca. Symptoms of endocarditis appeared December 13, 1893. Death, December 26, 1893.

Examination of urine made December 3d, 9th, 13th, and 21st. On the 3d and 9th there was a trace of albumen; on the 13th none; on the 21st a large trace. The sediment of the 3d and 9th showed a few hyaline and granular casts,

and a few fatty epithelial cells. The last examination, December 21, showed many hyaline and granular casts, epithelial casts, blood, and fatty epithelium. There is nothing with reference to the quantity of urine. On admission of patient the quantity was normal.

Autopsy. — No œdema. Acute ulcerative endocarditis of mitral and aortic valves. Both kidneys enlarged. Weight, 480 grmms. The capsule tense; on removal clings to surface in a few places. The surface of kidney of a dark-red color, with points of ecchymoses. On section, cortex 1 cm. in thickness. Striations obscure. Small pin-point ecchymoses scattered over it. The glomeruli are prominent and large, standing out from the cut surface, pale and refractive.

On microscopic examination of kidneys fresh there is no fatty degeneration. Portions of the kidney hardened in alcohol, and Flemming's. The glomeruli are very large, and filled with cells. In all cases they completely fill the capsule, and here and there project into the tubules. In some of the sections of the kidney apparently portions of the glomerulus containing a few capillaries are found in the tubules. These tubules evidently represent the section of tubules near the glomerulus, into which the loops project. The nuclei in the glomeruli are large, granular, some protoplasm can be seen around them, and they lie principally within the capillaries. A small number of polynuclear leucocytes are found among them. Here and there among the glomeruli there are found some in which there is complete obliteration of the capillaries affecting small areas. In these places the nuclei are extremely numerous, and between them there is a hyaline, partly homogeneous tissue. In the glomeruli so affected the vessels are more or less divided into masses, giving to the glomerulus a lobulated appearance. The tubules are widely separated, but not by any increase in the connective tissue. The tissue between the tubules is loose and reticular. There are a few leucocytes in the interstitial tissue.

Cultures from this case show pneumococci in the vegetations of the heart, and in the liver and kidneys. Pneumo-

cocci are also found in large numbers in sections of the diseased valves.

Case III. — Patient entered hospital September 29, 1894. Age 35. Two weeks before entry into hospital, thinks he took cold, and noticed swelling in feet and legs. Pain in chest and abdomen. Dyspnœa; inability to sleep. Appetite poor. At the examination, increased dulness over cardiac area. Systolic murmur of apex. Patient extremely weak. Œdema of feet and ankles. The condition continued until October 5th, when patient suddenly fell dead. Examination of urine on September 30th and October 6th, by specimen obtained after death by catheter, showed high specific gravity, slight trace of albumen, and faintly granular casts, epithelial casts, blood corpuscles, and fatty degenerated cells.

Autopsy. — Acute ulcerative endocarditis, with rupture of left auricle into pericardium.

Œdema of lower extremities and slight œdema of face.

Kidneys large, weight 460 grmms. Both of same size and general appearance. Capsule in places slightly adherent. Surface elsewhere very smooth and of a gray-reddish color. Somewhat mottled. In each kidney there are several fresh infarctions. On section the cortex is thicker, of a grayish-red color; markings obscure; glomeruli prominent. The vessels of pyramids injected. On microscopic examination of frozen sections there is a slight degree of fatty degeneration. Examination of tissues after hardening in alcohol, corrosive, and Flemming's solution shows marked increase of cells in glomeruli, chiefly in capillaries. Some granular degeneration of epithelium with necrosis and exfoliation of cells. Œdema of interstitial tissue with here and there areas of small cell infiltration. There is some hemorrhage within the glomerular capsules and in tubules.

Cultures show general pneumococcus infection. Typical pneumococci found in section of the cardiac valves. No organisms found in the kidney.

Case IV. — Patient entered hospital, December 7, 1894; ill for two weeks. Age 48. Illness began with sore throat,

vomiting, chills, pain in the stomach, and occipital headache. Face red and swollen. The condition seemed to improve up to the 12th, when she began to fail, and died on the 14th.

Examination of urine, December 8, showed traces of albumen, hyaline, brown granular casts, numerous red blood corpuscles, and pus cells. December 11, slight trace of albumen, red and white blood corpuscles, hyaline and granular casts. December 12, slight trace of albumen, many white and red blood corpuscles, and a number of very large casts. December 13, the same condition. The quantity of urine began to diminish from December 9. December 9, 200 cc. were passed; on the 10th, 90 cc.; on the 11th, 90 cc.; on the 12th, 30 cc.; and on the 13th, 50 cc.

Autopsy four hours after death.

Erysipelas of face. Congestion and œdema of lungs; acute splenic tumor. Acute cystitis. Multiple fibromyomata of uterus.

The kidneys, weight 560 grmms. Capsule pale, easily removed. Surface smooth, somewhat mottled. Scattered over the surface small pale areas often surrounded by more hyperæmic portions. Here and there minute red points. On section, cortex pale, extremely moist, striations somewhat obscure; irregularly mottled; width of cortex, 8 to 10 mm. Malpighian bodies prominent, refractive, and pale.

Microscopic examination after hardening in corrosive sublimate. There is considerable injection of blood-vessels of the cortex. The space between the tubules wide. Here and there red blood corpuscles in the tubules with a varying number of leucocytes. The epithelium of the tubules is narrow, granular, in places in marked degree hyaline. Here and there slight necrosis of the epithelium confined to single cells or to entire section of tubules. Granular detritis, hyaline, and granular casts in the tubules in the intermediate portion of the kidney and in pyramids. The glomeruli are greatly enlarged, filling the spaces and projecting into the tubules in many places. The capillaries evident and contain a few red corpuscles. The red corpuscles in this case are very evident, being stained vividly with eosin. All of the glomeruli present the same ap-

pearance. There is only a slight variation in the quantity of cells in them. With high power there are numbers of cells in and between the capillaries of the glomeruli. Many of these cells are large, with round granular nuclei and firm protoplasm. The majority of them appear to be polynuclear leucocytes. These are found both in the capillaries and outside of them between the mass of capillaries and the granular space. Some of the tubules leading off from the glomerulus also contain them. There are no leucocytes in the interstitial tissue of the kidney, so that those in the tubules have apparently come from the glomeruli. In some of the glomeruli there are areas affecting small groups of capillaries where the tissue has a more or less granular or homogeneous appearance, and which stains brightly with eosin. In these areas there are nuclei and nuclear detritis. The cell boundaries cannot be distinctly seen.

Examination for micro-organisms fails to reveal them. Cultures made from all of the organs including the kidneys show a typical streptococcus septicæmia.

Case V. — Man, age 26. No clinical history obtained. Brought into hospital moribund; died shortly after.

At autopsy œdema of lower extremities. Acute endocarditis of mitral valve with small inflammatory foci over endocardium of ventricle. Marked hyperæmia and œdema of lungs.

Kidneys large, weight 400 grmms. Capsule easily stripped off. Surface mottled with red and white points. On section, cortex pale red, markings obscure, pyramids congested. Glomeruli pale, prominent, and refractive.

Examination of kidneys hardened in alcohol and Flemming's solution. Great enlargement of the glomeruli; capillaries filled with cells; slight increase in capsular epithelium. In the specimen hardened in Flemming's there is considerable fatty degeneration both in the epithelium in the capsular space, and of the cells in the vessels of the glomeruli.

No bacteria found in the kidneys in the alcohol specimens. Cultures made at autopsy show pneumococci in vegetations of the heart, in the lungs, in the liver and kidneys.

Pneumococci were found in large numbers in the sections of valves.

Case VI. — In this case a portion of the liver, kidney, spleen, and uterus were brought to the Medical School for examination. The patient was one on whom labor had been induced for uncontrollable vomiting.

No clinical history with reference to the urine. No œdema noted. The portion of the uterus brought was of the thickness of uterus in latter period of pregnancy. It was quite soft, apparently fatty, slightly yellowish.

The liver of a dark-green color. The physician performing the autopsy said that it was larger than usual. No occlusion of the bile ducts.

On microscopic examination of the liver the cells were large, granular, and exceedingly fatty. Many of them contained a good deal of greenish bile pigment.

The kidney was large, weight of single kidney 262 grmms. Cortex easily stripped off. Surface yellowish with distinct greenish tinge. Cortex smooth. No appearance of hemorrhage. On section, cortex enlarged, pyramids congested, markings obscure. The glomeruli enlarged, pale, refractive, standing out from the cut surface as small grains of sand.

On microscopic examination glomeruli large, completely filling the spaces. The walls of the vessels of glomeruli thickened, granular, and hyaline. There is some, but not a great increase in the cells. In the capillaries there is more or less granular material. The tubules somewhat dilated. The epithelium swollen, granular, and in places hyaline. In places low and atrophic. There is marked fatty degeneration, especially in the tubules of Henle and in the small collecting tubules. In the cortex there is some increase in cells in the interstitial tissue around the glomeruli. A few of these cells are leucocytes. Most of them are large, with a large granular nucleus and with considerable granular protoplasm around it. No bacteria found in the kidneys on microscopic examination.

Cultures from the liver, kidney, spleen, and uterus show pure culture of streptococci.

Case VII. — Heart and kidneys brought to Pathological Department for examination. The heart shows extensive acute endocarditis of mitral valve with some chronic verucose endocarditis. In one place a distinct ulceration extending into valve.

The kidneys large, weight 500 grmms. Capsule easily stripped off. Surface mottled, succulent. On section, glomeruli large and pale. Small hemorrhages in tissue; markings obscure.

On microscopic examination the glomeruli very large, filling the capsules; very few red blood corpuscles in the glomeruli. The capillaries occluded with cells. Small portions of the glomeruli consisting in several capillary loops converted into more or less granular mass staining diffusely with eosin. On staining with Weigert's hyaline and reticular fibrin found in these places. Here and there a slight amount of fibrin in the tubules. In general there are but few leucocytes in the glomeruli except in those in which necrosis of capillaries is evident. In these places a small number of leucocytes are found. In the tubules there is considerable reticulum. The epithelium is granular and degenerated. In places much desquamation. Some of the collecting tubules are filled up with desquamated cells. The inter-tubular space increased. Slight increase of cells between the intertubular tissue. Vessels congested. No bacteria found in the kidneys on microscopic examination.

Cultures from heart show numerous pneumococci. Pneumococci found in sections of the diseased valves. Cultures of kidney sterile.

Case VIII. — Heart and kidney brought to Pathological Department for examination. No clinical history with reference to kidneys. In heart well-marked endocarditis of aortic valves with perforation of valves. The one kidney brought for examination weighed 230 grmms. Capsule easily stripped off; surface mottled; numerous fresh infarctions over surface. On section, cortex wide; glomeruli prominent; pyramids congested; cortex pale, reddish pink; very moist.

On microscopic examination, typical intra-capillary glomerulo nephritis, with small number of leucocytes among the capillary cells. Some hemorrhage in glomeruli and tubules. In the capsular spaces of a few of the glomeruli and in the tubules leading out from them fibrin is found. The epithelium of the kidney shows considerable fatty, granular, and hyaline degeneration, with desquamation. Granular detritis and casts in the collecting tubules and tubules of Henle.

Cultures from the heart show pneumococci. Pneumococci found also in section from valves. No organisms found in kidneys on examination.

Case IX. — From outside autopsy. Case of measles with old syphilis. No heart lesions; kidneys large, weight of both 550 grmms.; capsule easily stripped off; surface pale, mottled. On section, markings obscure, pale-red, somewhat mottled. Pallor most marked around pyramids; glomeruli prominent.

On microscopic examination, glomeruli very large, filling up the capsule; increase of cells in glomeruli. In many of the glomeruli there is a marked increase of cells in the capsular space. In some of the glomeruli the vessels appear to be compressed by the cells in the capsule. Slight hemorrhage into the glomeruli and in the tubules. Cultures show general streptococcus septicæmia.

Case X. — Well-marked visceral syphilis. Acute endocarditis, with rupture of cordæ tendinæ. Sudden death. No clinical history with reference to the kidneys obtained.

Kidneys large, weight not given. Both of same size and general appearance. Measurements of right kidney, $13 \times 6 \times 4\frac{1}{2}$ cc. Estimated weight of both kidneys, from measurements, 500 grmms.; capsule easily stripped off; surface pale-red, mottled, moist, opaque. On section, cortex mottled, glomeruli pale, prominent, refractive.

On microscopic examination, general increase of cells in glomeruli, some increase in capsular epithelium; extensive degeneration and necrosis of tubules. Some increase of

cells in the interstitial tissue with œdema, and in places some increase in connective tissue.

Cultures give general infection with streptococci. Streptococci also found in cardiac valves.

Case XI.—Man, age 37. Entered hospital August 1, 1895. Trace of albumen appeared in urine August 11. Irregular fever; tubercle bacilli in sputum. Patient left hospital September 28, and returned on October 17. On return, considerable œdema of ankles; urine showed considerable albumen.

No clinical record with reference to amount of urine passed. Autopsy, October 14, 1895. At the autopsy, tuberculosis with cavity formation. In both lungs a few areas of broncho-pneumonia. Acute endocarditis of tricuspid and pulmonary valves with distinct ulceration.

Combined weight of kidneys, 460 grmms. Capsule easily stripped off, leaving smooth, rather pale, mottled surface. On section, cortex pale, showing numerous yellow plaques and streaks. Glomeruli for the most part invisible or appear as pale-gray points. Pyramids moderately injected, but appear in sharp contrast to the pale cortex. Microscopic examination, after hardening in alcohol and corrosive sublimate.

There is a general diffuse increase in the connective tissue throughout the cortex of the kidney; in places combined with destruction of tubules. The glomeruli are large; the capillaries contain an increased number of cells with a few blood corpuscles. Many of the capillaries appear to be filled with a more or less granular-looking mass, and between the capillaries there appears to be some of the same material. No increase in capsular epithelium. Among the cells in the capillaries there are a few leucocytes. Here and there glomeruli are found with beginning lobulation and hyaline degeneration of groups of capillaries.

Cultures and cover-slips from the diseased valves show pneumococci in considerable numbers. A few colonies of pneumococci found in the cultures made from all the organs. Closer examination of the heart showed, in addition to the acute lesions of the valve, an older verucose endarteritis.

The case is interesting in showing a combination of the acute process in the valve with an older process. In the kidneys also evidence of an older process is seen in the connective tissue increase.

Case XII. — The case is one of articular rheumatism. The condition of the kidney was not recognized during life. At the autopsy the kidneys were found to be enormously increased in size; weight of both together 600 grmms. The capsule easily stripped off. The surface beneath the capsule a pale red with intensely red points and paler areas. On section, cortex greatly increased; markings of cortex obscure; pyramids congested and slightly increased in size. The section of kidney moist; on pressure abundance of fluid could be squeezed from it. Pits beneath pressure. The glomeruli are prominent and pale. They stand out from the cut surface of the kidney as very pale points.

Kidneys hardened in Zenker.

On microscopic examination with low power the most striking thing is the dilatation of the tubules, which for the most part are filled with a more or less granular-appearing mass which in most cases takes the form of small granular circlets. In places areas are found where the epithelium is denser, stains a deep pink with eosin, and where the nuclei stain more sharply.

With high power the epithelium everywhere is altered. In places it is enormously swollen and filled with granules. There is every transition from the appearance of very small granules in the epithelium up to that of hyaline masses in enormously swollen epithelial cells. The space between the tubules is dilated and the blood-vessels of the cortex generally injected. In some of the tubules, in the place of being swollen, the epithelium is very thin and somewhat jagged on the edge. The striated border of the cells is in places visible in the depressed areas. There does not appear to be any increase in the connective tissue. Where the tubules are widely separated there is a very fine reticulum between them. Those areas which with a low power show a reddish color to the epithelium are apparently necrotic. The epithelium here is more solid than elsewhere.

The nuclei are small, brightly stained, and shrivelled; exceedingly irregular, often angular. Sometimes epithelial cells so constituted are found. The glomeruli are large, they completely fill the capsule. In places they project slightly into the tubules. The cells are somewhat, but not greatly increased. With high power they appear to be more solid.

Many of the cells contained in them are undoubtedly in the capillaries. In some of them there are leucocytes in the capillaries. In addition to these cells there is a granular-looking material in the capillaries, and occasionally a red corpuscle. There is no hyaline change. The absence of red corpuscles is striking; those which are present stain a bright red. There is no increase in the cells in the interstitial tissue.

Cultures of organs sterile.

Case XIII. — Kidney and bladder brought to Pathological Department.

Man, aged 34. History of long-continued gonorrhœa. Urethra not examined. Bladder hypertrophied. The mucous membrane thickened, cloudy, injected. Here and there small hemorrhagic foci. Slight fibrinous exudation at base. The uterus dilated. The mucous membrane of the pelvis of kidney moist, very much thickened with a few small erosions. No deep ulceration. The papillæ slightly atrophied. A grayish zone along the edge of the papillæ where they project into the pelvis. The kidney enlarged. Capsule slightly adherent. Surface rather pale grayish-red, mottled.

On section, kidneys moist, cortex considerably increased in thickness, the tissue denser; glomeruli pale and prominent. Tissues hardened in alcohol and corrosive sublimate. On microscopic examination purulent infiltration with necrosis along the border of pyramids extending up a slight distance. In various places in the kidney some foci of purulent infiltration, pus cells both in the interstitial tissue and in tubules. There is a general though slight increase in connective tissue everywhere in the kidney. The tubules show extensive granular and hyaline degeneration. In

places the epithelium is desquamated. The glomeruli are large; the capsular space entirely obliterated. In many of the glomeruli there is a proliferation of the capsular epithelium. In all the glomeruli the cells are increased in number. These cells lie principally in the capillaries. Among the cells in the capillaries are a number of polynuclear leucocytes. Leucocytes are also found among the cells in the capsule.

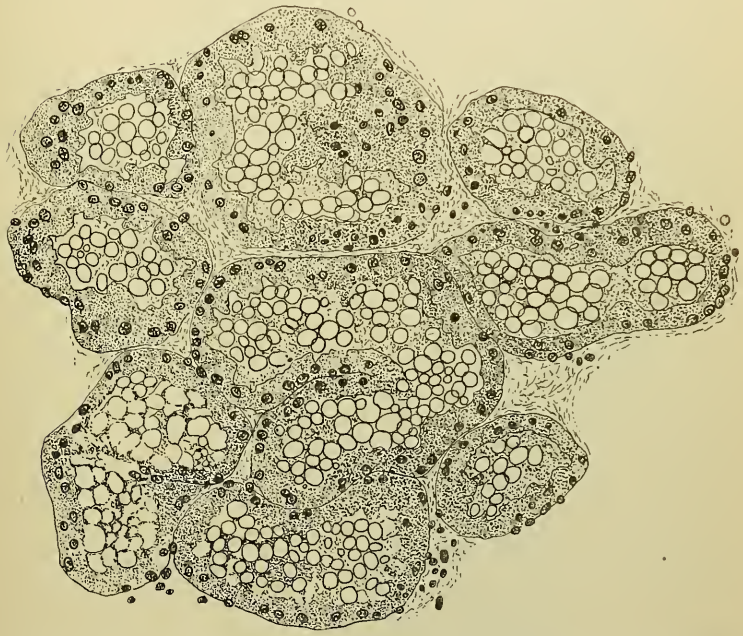


FIG. IV. — Section of kidney from Case XIV., showing circular reticulum in the tubules. Zeiss D. camera.

Cultures from the kidney on ordinary media show colon bacilli. The most careful search for micro-organisms in sections of the kidney does not reveal their presence.

Case XIV. — The individual a large negro man of about thirty-five. Died suddenly. From statement of his friends he had been sick for several days. At the autopsy, general œdema and anasarca. Acute endocarditis of all of the valves of the heart; most marked in the mitral and aortic. Ulceration of aortic valves. Aneurism of sinus of Valsalva. General arterio sclerosis.

Both kidneys greatly enlarged. Weight of both, 575 grmms. Capsule easily removed. Surface smooth, slightly uneven, pale. General color, pale pinkish with more opaque whitish portions. All over the surface there are small bright-red points. On section, sharp differentiation between cortex and pyramids. Markings of cortex obscure, with here and there paler opaque reddish masses. Glomeruli prominent, large, and pale. Kidneys fracture easily. Test with iodine negative.

Kidneys hardened in alcohol and Zenker. Marked epithelial degeneration. In places the tubules contain only fragments of epithelial cells along their walls without nuclei. The tubules in most cases widely separated by interstitial œdema. (Fig. IV.)

A marked feature in this case is the circular reticulum in the tubules. This fills all of the tubules in the cortex. In places it is found in the glomerular spaces. The glomeruli are enlarged. In the capsular space there is a small amount of coagulated albumen. The epithelium of the glomerulus and of the capsule is swollen and granular. The glomeruli contain an increased number of cells. This is not so marked as in some of the other cases. Many of the blood-vessels of the glomeruli are still open, and in some there is a small number of red blood corpuscles. The walls of the capillaries of the glomeruli are in places thickened and hyaline. Some of the capillaries appear to be occluded by granular material. The connective tissue around a few of the glomeruli is thickened.

The capillaries of the cortex are injected in a few places, and here and there hemorrhage is found in groups of tubules; there is comparatively well-marked endarteritis in the renal arteries. The mass, presumably of coagulated albumen, in the glomerular capsule is partly in the granular form, and partly shows the same circular reticulum as in the tubules. An interesting feature of this case is the presence, in the capillary spaces of the glomerulus, of small masses of epithelial cells which do not belong to the glomerular capsule, and which represent loosened epithelium from the convoluted tubules which has been pressed up into the capsular space. This is the same condition which was described by

Welch in the kidneys of white rats after poisoning with cantharadin. (Fig. V.) This is the only case in which I have found this condition. Cultures from spleen and kidney negative. Cultures made from heart show a large number of contaminating organisms. On section of the valves pneumococci were found.

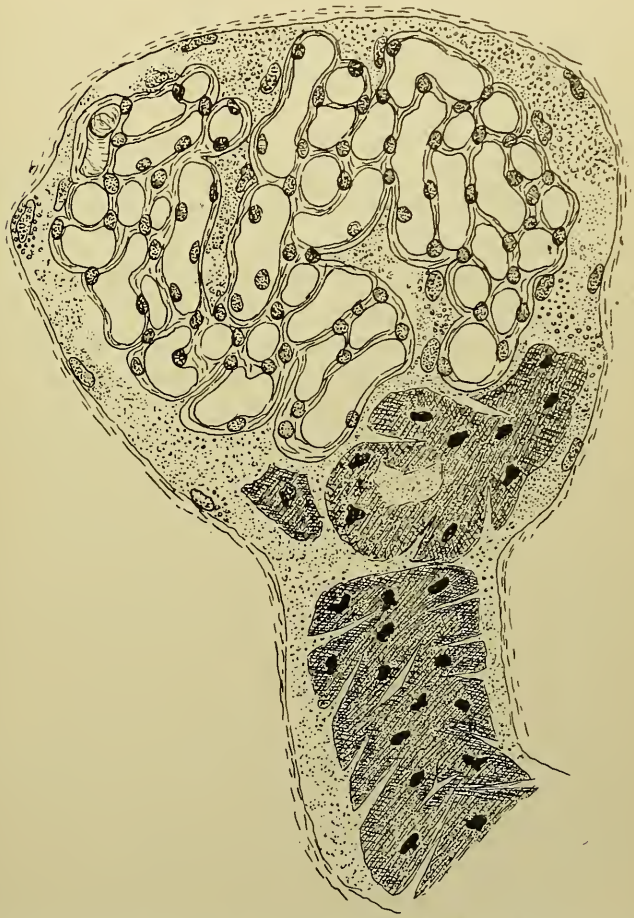


FIG. V. — Kidney of white rat after cantharadin poisoning. The epithelium of the tubule leading from the glomerulus is necrotic, and a part of the necrotic tissue has been forced into the capsular space. Zeiss D.

Case XV. — Autopsy, February 12, 1896.

Clinical history. Entered hospital February 3. Twelve days before entry into hospital, said to have caught cold and had considerable cough. Two days before entry, face and

legs began to swell. At time of entry, œdema of lower extremities and of face. On the 7th, œdema of feet. Complains now of dyspnœa. Had had considerable diarrhœa for last two days. On the 9th complained greatly of dyspnœa. Condition gradually became worse, and died on the 11th.

The lower extremities, neck, upper portion of thorax and wrists, very œdematous. Ascites. Old tuberculosis of left lung. Acute fibrinous pneumonia of lower and part of upper lobe of left lung.

Both kidneys enlarged. The right, weight 230 grmms. Left, 210 grmms. Left kidney, capsule strips off easily, leaving smooth surface. General surface pale. Stellate veins greatly injected. Here and there on the surface is a pin-point ecchymosis. Remains of fœtal lobulation. On section there is a sharp contrast between cortex and pyramids. The pyramids are more transparent. The veins moderately injected. Cortex swollen, average thickness 1 cm., of a pale reddish color; markings obscure. Glomeruli opaque. The right kidney is distinctly paler than the left; otherwise the same.

Frozen sections of kidneys fresh show a general diffuse fatty degeneration.

Sections of the kidney examined after hardening in alcohol and Zenker. On examination with low power the most marked thing about the kidney is the dilatation of the tubules and the small size of the epithelium. The convoluted tubules are everywhere lined with low epithelium. The space between the tubules is increased. The capillaries of the cortex are most of them injected with blood and somewhat dilated. The glomeruli are all enlarged. With a low power the number of cells in the glomeruli are very prominent. The lobulation is somewhat more marked than normal. In a few places there seems to have been some atrophy of the tissue. The connective tissue in these places is greatly increased, and in the connective tissue atrophied tubules and remains of tubules are found. With a high power the circular reticular mass in the convoluted tubules is very prominent. Some of the tubules are filled with granular material which stains with eosin. There are a few

red and white corpuscles in the tubules. In general the hemorrhage is inconsiderable. In some cases the dilated tubules are lined with epithelium which seems to be normal. The cells seem to be smaller from distension and the striated border is preserved. In others the cells are greatly swollen and granular, and in still others they are small, in part cast off, and extremely irregular. The glomeruli are much denser than normal. In many of them normal capillaries filled with red blood corpuscles are found. In most cases they are closed. There appears to be within the vessels of the glomeruli a more or less granular reticular mass. The epithelial cells covering the glomerular capillaries are enlarged, but there is no general growth of the epithelium of the capsule. The closure of the capillaries does not appear to be due so much to the increase in the cells as to a rather indefinite thickening due to deposit of material within and around the capillaries. No hemorrhage and a very slight amount of fibrinous material is found around the glomerulus. The report of the urine in this case made on February 10, 1896, two days before death, showed the amount reduced to 600 cc. One-half of 1 per cent. of albumen, hyaline, granular and epithelial casts, with fatty epithelial cells.

The bacteriological examination shows large numbers of pneumococci in the pleuritic exudation and in the pneumonic lung. Few pneumococci in liver, spleen, and kidneys.

Case XVI. — General health good before time of entry into hospital. Entered hospital, October 17, 1895, with œdema of extremities and scrotum. Left hospital, November 15, 1895. Nineteen days before entering hospital on January 28, 1896, œdema began again; dyspnœa extensive. Amount of urine diminished greatly. Condition gradually increased in severity, and died February 4, 1896.

Autopsy, February 5, 1896. Large, well-developed man, about 27 years old. General œdema. Marked œdema of glottis. Slight broncho-pneumonia in both lungs. Heart atrophy and dilatation.

The kidneys very large, weight of both together 880 grmms. Both of same size and general appearance. The capsule thin, easily stripped off. Surface beneath capsule

smooth, of a pale pinkish color, with more opaque areas. On pressure the tissue pits. On section there is a striking difference between pyramids and cortex. The pyramids themselves appear to be somewhat enlarged. The veins stand out prominently, and the tissue between is rather pale and translucent. The pyramids are marked out by a yellowish-red opaque zone immediately around them, of a general width of 3 mm. In places it is somewhat irregular. The cortex of the kidney has an average width of 1 cm. and is somewhat mottled. There are pale lines more translucent than the others, which appear to be the continuation of the tissue of the pyramids. Between this the tissue is more opaque. The glomeruli are everywhere visible. They stand out sharply above the cut surface. They are pale and refractive.

Microscopic examination shows extensive fatty degeneration, particularly around the pyramids. The most extensive fatty degeneration appears in some of the collecting tubules, which are dilated as well.

Sections of the kidney examined after hardening in Zenker, and stained in various ways. There is a marked degree of degeneration of the epithelium everywhere in the kidney. The tubules are somewhat dilated. In places the epithelial cells are distinctly necrotic; in others they appear to be atrophic. Many of the tubules are deprived of epithelium over considerable areas, and in some of the collecting tubules there are long convoluted masses of adherent epithelial cells. The intertubular tissue everywhere in the kidney is enormously dilated. There is a slight increase in the number of cells in this tissue, and among the cells here and there leucocytes outside of the vessel are seen. A few leucocytes are found in the tubules mixed with detritis and with cast-off epithelial cells. All of the glomeruli are altered to a greater or less extent. In but a few places can blood-vessels be made out with distinctness. The cells in the glomeruli in some places are increased in number, in other places in the same glomerulus there are very few. The lobular division of the glomerulus is very apparent. On section, four or more distinct lobules are made out. The vessels are very generally obliterated, and converted into

more or less hyaline and granular masses. In these in some places nuclear detritus can be made out, and leucocytes both normal and degenerated. In almost all cases there is a decided thickening of the capsule. Usually the old line of capsule can be distinctly made out, appearing as a refractive line somewhat similar to the elastic coat of an artery. The number of cells in the thickened tissue varies. Where the growth is small and apparently recent, they are numerous. In other cases, very few. In some cases where the thickening is extreme the cells have almost disappeared, and in the place of the definite epithelial cells, a rather loose connective tissue is found. In the collection of cells around the glomerulus, spaces are frequently seen which are definitely lined with epithelial cells. Between these epithelial cells, cells of another character appear. These have long nuclei, and appear to be of connective tissue origin. Blood-vessels are here and there found in the thickened capsule, and in places there is a distinct fusion between the capsule and the vessels of the glomerulus.

The large size of the kidney in this case appears to be due to the dilatation of the tubules and the œdema of the interstitial tissue. Cultures show all the organs sterile with the exception of liver and spleen, in which there is a growth of colon bacillus.

Case XVII. — Child, $2\frac{1}{2}$ years. Interlobular pneumonia with abscess. Weight and measurements of kidney not given.

Kidney somewhat enlarged, capsule easily removed, surface mottled. Pale, opaque areas in cortex. Glomeruli not apparent. On microscopic examination, after hardening in alcohol and corrosive, there is considerable epithelial degeneration and granular detritus; casts in tubules; the glomeruli not distinct, enlarged. Some increase of cells in glomerulus.

The most marked feature in this case is the extensive hyaline thrombi in glomeruli. In some of the glomeruli the hyaline material fills up almost every capillary. In many of the capillaries there is a considerable amount of reticular fibrin, and fibrin is also found in the tubules leading off from

them. The hyaline material in the glomerular capillaries gives the typical fibrin stain with Weigert's.

Cultures show general staphylococcus septicæmia.

Case XVIII. — No clinical history and no macroscopic description of kidneys. Child, 2½ years. Death from measles and broncho-pneumonia. There are numerous hemorrhages in the kidney; in places several tubules completely filled with blood. The glomeruli not enlarged. No increase of cells either in the capillaries or in the capsule. In many of the capsular spaces there is considerable reticular fibrin and the capillaries of the glomeruli contain hyaline and reticular fibrin. In many places the tubules are filled with distinct fibrinous masses.

No cultures made from case, but the probabilities are that there was a general streptococcus septicæmia.

Case XIX. — Child, age 5 years. Admitted to hospital January 5, 1895, with diphtheria. Depression and loss of appetite. On the 17th vomiting began and has been persistent. Bleeding at the nose on the 21st. On the 23d developed erysipelas of the forehead from a scratch with his finger-nail. Death on 26th.

No urine could be obtained for examination.

Autopsy, January 27, 1896.

No œdema. Broncho-pneumonia of both lungs.

Kidneys both enlarged, of same size and general appearance. Combined weight, 300 grmms. Capsule easily stripped off. Surface smooth, pale, grayish-white with pinkish mottling. On section, cortex pale-gray, much increased in size; the glomeruli prominent. Many of them red and apparently enlarged. Markings obscure. Pyramids small and blunted. Intensely congested.

Kidneys hardened in Zenker. On microscopic examination of kidneys with low power they present a somewhat confused picture. The spaces between the tubules and cortex are somewhat dilated. There is no general increase of cells in the cortical portion of the kidney, though around some of the glomeruli more cells seem to be present. Some of the tubules are dilated. In others the epithelium

is very high, almost closing up the lumen of the tubule. The tubules stain irregularly. The glomeruli are not prominent on microscopic examination, because there is no space between the vessels of the glomerulus and capsule. Around some of the glomeruli there are masses of fibrin and blood. With high power there is great irregularity in the epithe-

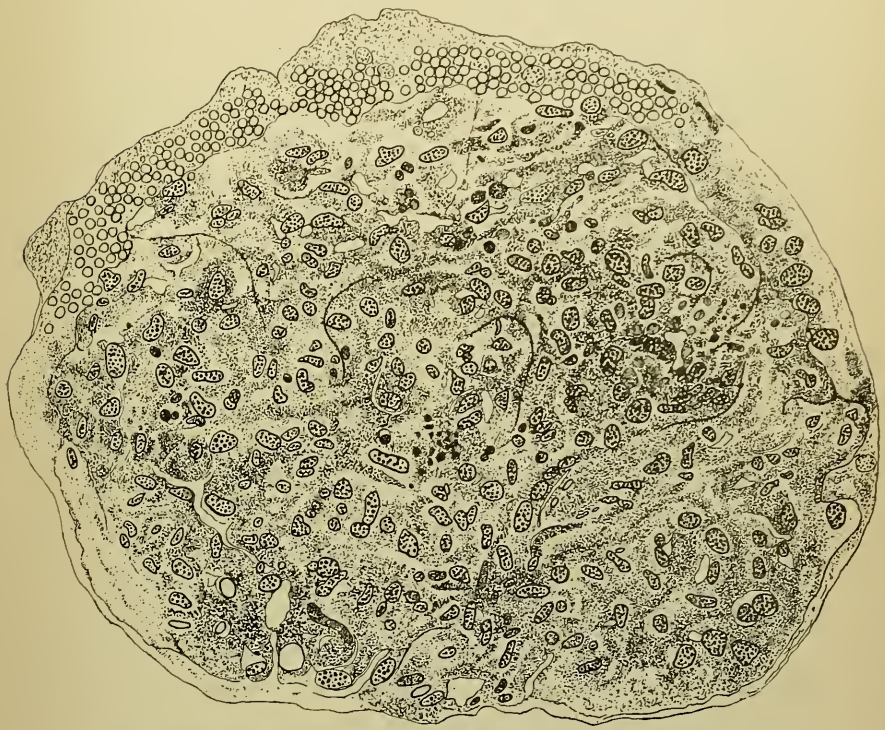


FIG. VI. — Section of glomerulus from Case XIX. Nothing can be made out of the normal structure. Most of the vessels are occluded by cells and granular detritus. In a few places the lumen is seen. There is considerable necrosis and nuclear detritus. 1-12 immersion camera.

lium of the tubules. The striated border is nowhere perceptible. In many cases the epithelium is greatly swollen and the entire mass converted into hyaline. In many of the epithelial cells so altered, the nucleus stains perfectly and appears but little changed. This hyaline degeneration of the epithelium is very extensive and affects not only the convoluted tubules, but the other tubules in the cortex. The loops of Henle are indistinct, but the epithelium is a very little degenerated. In some of the convoluted tubules

the cells are greatly enlarged, swollen, and filled with small clear spaces. Large irregular masses composed of hyaline droplets are found in some of the tubules. In the interstitial tissue of the kidney, especially in the intermediate zone and in the cortex around the glomeruli, there is infiltration with cells. These cells lie in preformed spaces. The spaces often contain blood corpuscles and are similar to capillaries. The cells within them vary greatly in their size and appearance. Most of them are considerably larger than leucocytes. They have a firm deeply staining epitheloid nucleus with a very distinct reticulum within the nucleus and a variable amount of finely granular protoplasm. Capillaries are found with evident swelling of the nuclei of the epithelial cells. Among these large cells lymphoid cells are found and numbers of polynuclear leucocytes. The polynuclear leucocytes are greatly enlarged. Some of the large cells contain two nuclei, but no definite nuclear figures can be seen. The exact condition of the glomeruli can be made out with difficulty, on account of the extent of the change within them. There is a marked increase in the number of cells. (Fig. VI.) Almost all of the capillaries are obliterated. Only here and there in the glomeruli can any red corpuscles be distinguished. Among the cells in the glomeruli there are numbers of polynuclear leucocytes. Outside of the glomerulus there is some fibrin, a considerable amount of blood, and numerous flattened cells. In other places the glomerulus seems to be converted into a confused more or less granular necrotic mass in which there are few nuclei. In other places there seems to have been very extensive hemorrhage into the tissue of the glomerulus which completely obscures the detail of the structure. In the less altered glomeruli the capillaries appear to be frequently entirely occluded and filled up with a mass which is partly smooth and hyaline, and partly granular.

Cultures from the case show large numbers of diphtheria bacilli and streptococci in the diphtheritic lesions of the pharynx and in the larynx and in the lung. Elsewhere in the organs general streptococcus infection. In some of the small veins in the pyramids of the kidney masses of cocci are found on section.

In the following cases nothing is known of the clinical history and the accompanying disease.

The kidneys are old specimens in which little beyond the condition of the kidney was noted.

Case XX. — The kidney enlarged, capsule adherent, surface slightly irregular, pale-red, mottled.

Kidneys hardened in alcohol.

This case is of interest in showing an extremely well-marked arterio-sclerosis of the arteries. There is marked increase of the connective tissue in places extending in streaks up to the surface. In these areas the tubules are degenerated and in part completely destroyed. The glomeruli are enlarged, many of the vessels occluded with hyaline thrombi and with nuclear detritus. Hyaline and reticular fibrin found in the capsule of the glomerulus and in tubules. In places hemorrhage in capsular spaces and in tubules; leucocytes in the glomerular capillaries, in capsular spaces, and a few in the tubules.

This case is interesting as showing an acute glomerular affection occurring in a chronic arterio-sclerotic kidney.

Case XXI. — Kidney from scarlet fever.

Microscopic examination shows an adult kidney. The glomeruli very large, the capsules dilated and filled with epithelial cells. The cells in the glomeruli increased in number. Among these cells considerable numbers of leucocytes. Leucocytes are also found in the tubules and here and there in small numbers in the interstitial tissue. The intertubular tissue dilated. No increase in the connective tissue. No proliferation of the interstitial cells.

Case XXII.—Nothing known of history of case. Typical intracapillary glomerular changes. The glomeruli very large, the capsule distended. Considerable proliferation of epithelium in capsular space. Numbers of leucocytes in the glomerular capillaries. None were found in the capsular spaces. Considerable numbers of leucocytes in interstitial tissue and in tubules. Great degeneration of epithelium of tubules; in places large areas of necrosis and accumulation

of strings of epithelial cells in collecting tubules. In some places granular masses, in which here and there a nucleus could be recognized, in the tubules. Some of the tubules are filled with blood.

Case XXIII. — Acute glomerular changes; enormous increase of cells in glomeruli; in places necrosis of loops of capillaries; reticular fibrin in the capsular space and here and there in the tubules. In some of the glomeruli groups of capillaries are converted into smooth hyaline masses containing numerous leucocytes with some nuclear detritis. Extensive degeneration of epithelium, in places well marked hyaline degeneration; in places necrosis and desquamation. Dilatation of intertubular tissue.

Case XXIV. — Typical glomerular change. Glomeruli large; cells in capillaries enormously increased in number, slight increase in glomerular epithelium. Dilatation of intertubular tissue, extensive degeneration of epithelium of the tubules.

Case XXV. — Glomeruli enlarged; cells increased in number. No proliferation of capsular epithelium. In almost all of these glomeruli there is a more or less extensive lobulation, and in places groups of capillaries are converted into hyaline masses in which the lumen of the capillaries cannot be distinguished.

This case illustrates the more chronic form of glomerular change and forms a connecting link between the acute and the chronic.

REVIEW OF HISTOLOGICAL LESIONS.

In these twenty-five cases lesions of various sorts were found in the glomeruli. In placing them all among the acute cases the character of the lesions and not the clinical history has been considered. In those cases in which a clinical history referable to the kidneys has been obtained the lesions considered anatomically as acute have agreed with the clinical history. In determining the acuteness of the process from an anatomical point of view, the abundance

of cells and the slight character or absence of connective tissue increase have been mainly considered. Although these glomerular lesions vary, and lesions of a different character to some extent are found in the various diseases with which the nephritis is associated, the various processes are too often combined to warrant us in arranging them into different classes, based on the accompanying infection.

The Intracapillary Lesions.

Proliferation in and among vessels of the glomerulus was observed in all but two cases. In a number, particularly in Case I., this was the only change. On microscopic examination with a low power the glomeruli are prominent from their increased size and the abundance of cells. They fill completely the capsular space, and the capillary loops opposite the tubule, leaving the glomerulus, often project a considerable distance into this. In sections these projecting masses into the tubule may be cut across, showing portions of capillaries lying within the tubule. Serial sections and sections cutting the glomerulus in other directions will show that they are always connected with the mass of capillaries. In these glomeruli there is no appearance of a division of the capillaries into separate masses. In those cases regarded as most acute the capillary walls could be clearly distinguished. The walls of the capillaries are refractive and often seem slightly thickened. The cells in some cases can be clearly shown to lie within the capillaries, but this is only the case in cross-sections of the vessels and very favorable longitudinal sections. The vessels are so small and their course so tortuous that only by the most exact focusing can we distinguish those cells lying in the vessels from those outside. The special cells in the vessels are not leucocytes. In many cases leucocytes are found among them, and in some cases, notably in Case IV., they were very abundant. The polynuclear leucocytes can always be distinguished from the other cells by their characteristic staining and the form of the nucleus. The size and staining of the nuclei of the intracapillary cells and the character of the protoplasm distinguish them from the lymphoid leucocytes. The cells

lie partly within the lumen of the vessel, partly they are attached to the inner wall. The nuclei are granular, they stain brightly, but not so brightly as the nuclei of leucocytes. The protoplasm of the single cells is difficult to make out. Most often the protoplasm of neighboring cells is joined together, forming a rather irregular mass. In shape the nuclei are usually round, sometimes oblong or irregular. They can be distinguished from the nuclei of the epithelium covering the capillaries, by the oval shape and more vesicular character of the latter. In the glomerulus there is a slight amount of connective tissue which extends from the root among the vessels. The cells belonging to this connective tissue may proliferate and add their quota to those coming from other sources, and cannot be distinguished morphologically from those within the vessels. The intracapillary cells in many cases are very similar to those found in acute interstitial nephritis, and which can be clearly shown in many cases to be within the vessels. In all cases the absence of red corpuscles in the capillaries of the glomeruli was conspicuous. In the specimens which were hardened in corrosive sublimate or in fluids into whose composition this entered, the red corpuscles could be stained vividly in various ways; and in some cases none, in others very few were found. With increase in cells within the vessels there was often associated a thickening of the wall which seemed to take place on the inside. The edge toward the lumen was irregular, and in some cases the lumen was almost obliterated. In addition to the cells a more or less irregular, sometimes granular material was found in the capillaries which could be shown to be composed of the protoplasm of united cells. It sometimes formed a reticulum among the cells, or by itself. This material did not stain as fibrin, and may have been composed of the remains of degenerated and necrotic cells.

The extent to which the leucocytes took part in the process is interesting in view of the fact that some observers have considered most of the cells within the glomerulus to be leucocytes. In but one case, No. IV., were they found in the glomerular vessels in any numbers. Some of the capillaries in this case were filled with them, and they were

found in considerable numbers in the capsular spaces and in the tubules. Both Horteles and Ribbert deny that emigration takes place from the glomerular vessels. In some sections in this case they were seen in the act of emigration, part of the cell being within and part without the vessel, and both those in the glomerular capsule and those in the tubules were most probably due to emigration from the glomerular vessels. In other cases they were found in small numbers and evidences of emigration were not observed. In those cases in which necrosis of groups of vessels was seen, leucocytes and nuclear detritus were found in the necrotic tissue.

Hyaline thrombi were found in the vessels in three cases. In one of these all of the capillaries in some of the glomeruli were occluded. The thrombi were perfectly homogeneous, highly refractive, and gave the characteristic fibrin reaction with Weigert's fibrin stain. Ribbert described such hyaline thrombi in the kidneys of rabbits after staphylococcus infection, and they have been found in a variety of acute infections. They appear to be more common in animals than in man. In one case they were found in a child with staphylococcus septicæmia, and in the other two no cultures were made. In one of these from the character of the lesions streptococcus infection was probable. Fibrin, both within the vessels and in the capsular space and in the tubules, was found, both associated with hyaline thrombi, and without this. In one case so much fibrin was present that it must have played an important part in the formation of casts.

Necrosis of the glomeruli affecting small masses of capillaries was well marked in two cases, Nos. VII. and XIX., and a slight degree was seen in some of the other cases. In the necrotic portions the details of the tissue could not be made out. The whole tissue was converted into an indefinite granular mass which stained with eosin, and in which Weigert's stain showed some filaments of fibrin. Leucocytes and nuclear detritus were found in it.

Proliferation of the capsular epithelium plays a prominent part in the glomerular changes. In some cases this was so marked that on a superficial examination the other lesions could have been overlooked. Although more marked in

some cases than in others, it is impossible to divide the cases according to this lesion. It was especially evident in two cases, but was present to some extent in nearly all. Even in Case I., which was the most typical of the intra-capillary forms, among the cells there were some which from the large size and vesicular character of the nuclei must have been derived from the epithelium. The capsular

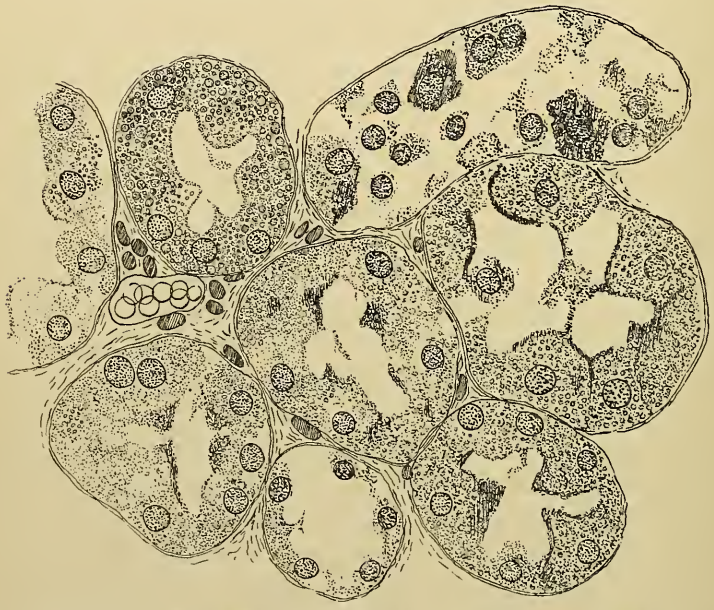


Fig. VII. — Granular degeneration and necrosis of epithelium of convoluted tubules from Case XIX.

epithelial cells formed crescentic-shaped masses between the glomerular tuft and the capsule. The cells were usually flattened by mutual pressure, and the nuclei deformed. In some the nuclei lost their power of staining, and the cells were converted into a more or less granular, apparently necrotic mass. Very greatly hypertrophied capsular cells connected with the capillaries by a long foot-stalk were occasionally found. Nuclear figures in small numbers were found in the capsular epithelium.

THE TUBULES.

Dilatation of the tubules was often observed and is difficult to explain. It is possible that it may have been due in

part to pressure exerted on the tubules in some part of their course by the œdematous intertubular tissue. In part it may be explained by blocking up the tubules by casts and epithelial detritus. (Fig. VII.) Fatty degeneration of the epithelium was found in some degree in almost all cases, but was in none excessive. The extreme degree of fatty degeneration which is found in phosphorus poisoning,

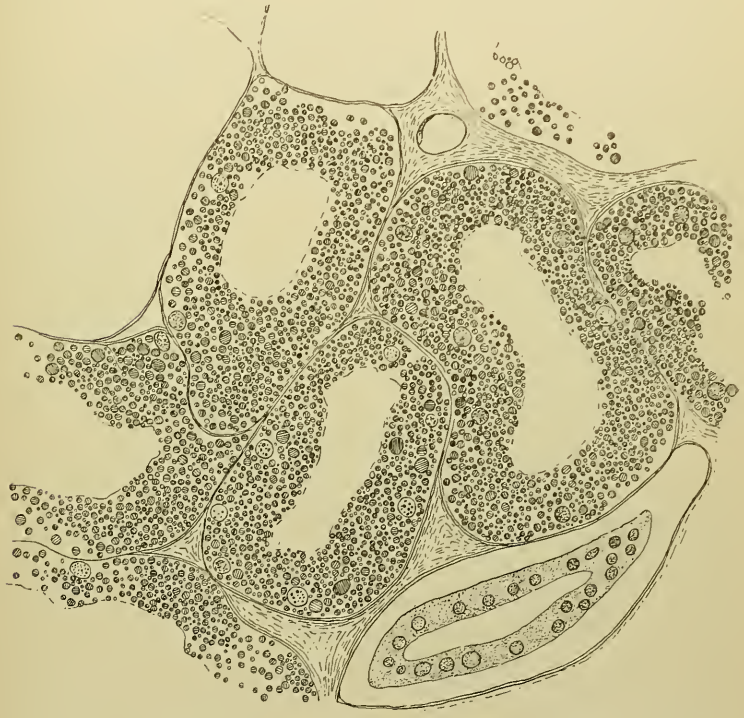


FIG. VIII. — Hyaline degeneration of epithelium of convoluted tubules. The nuclei of the cells are partly preserved. 1-12 obj. camera.

jaundice, and acute anæmia was never present. The fatty degeneration was generally diffuse, affecting all the tubules, and the fat was in fine granules. In some of the specimens hardened in Flemming's solution fat was found in the capsular epithelium, and in the cells within the glomerular capillaries. In Case XIX. the fatty degeneration was most prominent in the intermediate part of the kidney. Granular and hyaline degeneration was found. In the latter, single cells were found enlarged and filled with smaller and larger

hyaline drops. Sections of single tubules or groups of tubules were found filled with hyaline material. The nuclei of such cells were in some cases fairly well preserved; in others, either they did not stain or were small, solidly stained, and shrunken. Single hyaline degenerated cells on masses of hyaline partly preserving the globular form and partly moulded into hyaline cylinders were often found in the

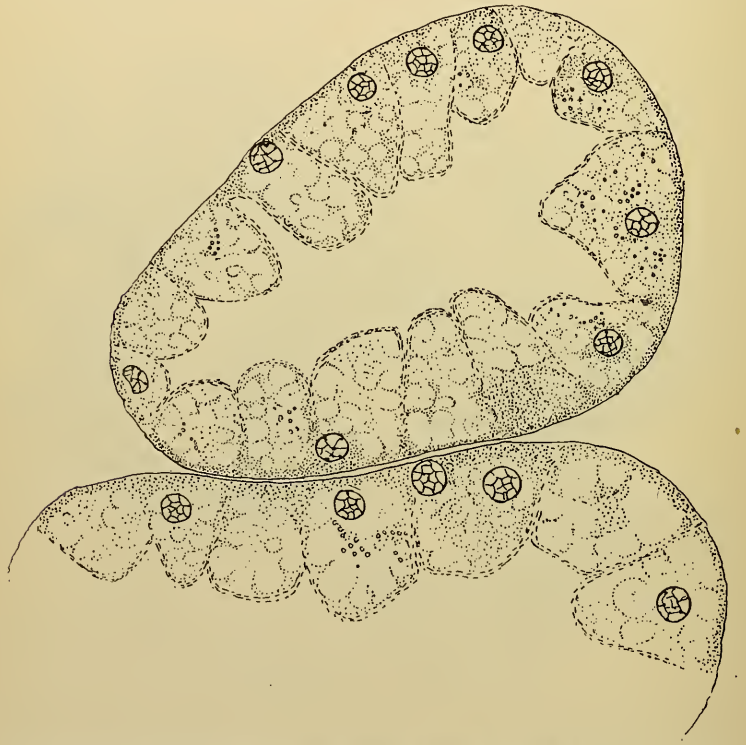


Fig. IX. — Granular degeneration and œdematous swelling of cells of convoluted tubules with preservation of nuclei. 1-12 obj.

tubules, having evidently come from nearer the glomerulus. (Fig. VIII.) In some of the dilated tubules the epithelium was simply atrophic. Necrosis affecting single cells and groups of cells was frequently seen. The single necrotic cells could be distinguished from the others by the homogeneous staining of the protoplasm, and by the absence of granules or shrivelling of the nucleus. In some places the epithelium was enormously swollen, very clear, and filled with small spaces. (Fig. IX.) In the descriptions of the lesions

reference is often made to a particular reticulum in the lumen of the tubules. This was formed of smaller and larger fine circles joined with one another in various ways. Granules are often present both in the edges of the circles, within and around them. With fuchsin the circles and granules often stain as brightly as do the nuclei. A reticulum of this character may be seen in the simple, degenerative lesions of the kidney. It was often found in the capsule of the glomerulus. In one case it was very prominent, almost every tubule being filled with it. The source of this peculiar reticulum, which is not confined to the kidney, or its nature, I do not know. I have never seen any appearances to make me believe that it can be a substance secreted by the cells. The swollen end of a cell may occasionally be so cut by the microtome knife that it may appear as a circle in the tubule, but it is obvious that such an explanation will not suffice. An albuminous secretion coagulated by the hardening agents does not take such a form, but is represented by a granular or homogeneous mass depending on the hardening agent.

THE INTERSTITIAL TISSUE.

The most marked change in the interstitial tissue is œdema, and the increased size of the kidneys, in one case reaching 880 grmms., is chiefly due to this. The space between the tubules may be very wide and is filled with a thin, sparse reticulum, in the midst of which run the vessels. The œdematous condition of the kidney is evident also on macroscopic examination. The tissue is more succulent than normal, and in some cases pits on pressure. In the typical acute cases there is no actual increase in the connective tissue fibrillæ. In those cases in which the lesions of the glomeruli approach the subacute form, as shown by the beginning lobulation and hyaline degeneration of groups of vessels of the glomeruli, the widened interstitial tissue is denser and contains more cells. The cellular increase takes several forms. In the intermediate zone there is often small cell infiltration around the larger vessels, particularly around the veins. These cells are small, and similar in

character to the lymphoid cells of lymphatic tissue and of the blood. As we have said, in the normal kidney small collections of such cells, probably representing small areas of lymphatic tissue, are often found around these vessels, and the increased number of cells may represent hyperplasia of this tissue. In other cases the cells are of a different character. They are large, the nucleus stains brightly and contains considerable chromatin and reticulum. The protoplasm is finely granular and stains more intensely than the protoplasm of the epithelial cells. These cells are frequently found within the vessels, and many of them certainly come from proliferation of the endothelium. In several cases these cells were present in variable numbers, and in Case XI. they were so numerous as to almost warrant us in regarding this case as a mixed form of glomerular and interstitial nephritis. In one case the connective tissue and vessels showed the lesions of arterio-sclerotic nephritis, and superadded to this there were acute lesions of the glomeruli.

MACROSCOPIC CHARACTERS.

In all cases the kidneys were enlarged. In adults the weight varied between 400 and 880 grmms. The average weight was 517 grmms. Orth gives the normal weight of adult kidneys in males as 320 grmms. and in females as 293 grmms., which is slightly under the average which I have found. The weights were taken after removal of the capsule and the adherent tissue of the pelvis. The capsule is sometimes hyperæmic; it strips off easily, often parting of itself from the swollen kidney after section. The surface is smooth or may be irregular from accompanying infarctions or previous disease. The color varies, being usually of a light pinkish tinge and mottled from varying degrees of congestion. There are usually small whitish foci varying in size, marking areas of more intense fatty degeneration, and small points of ecchymoses. On section the tissue is distinctly moister than normal. A thin opaque fluid is easily squeezed from it, and it pits on pressure. The cortex is increased in size, and the markings are obscure. In the section of the cortex the same small opaci-

ties and ecchymoses may be observed as on the surface. The glomeruli are pale and bloodless. In most cases they are easily visible, and they stand out from the cut surface, appearing as grains of fine sand sprinkled over it, and are refractive. The pyramids are usually enlarged, but relatively much less than the cortex, and may be hyperæmic.

BACTERIOLOGICAL INVESTIGATION.

The presence of bacteria in the kidneys or in the accompanying acute lesions was noted in seventeen cases. Their presence was determined by cultures, by microscopic examination of cover-slips, and by microscopic sections. In making the cultures slant tubes of the Loeffler blood-serum mixture were used exclusively. Portions of the tissue from the different organs were rubbed over the surface of this, and dilutions were often made, but usually they were not necessary. This medium is the best general medium for use at autopsies. Organisms which grow on other media with difficulty grow on this vigorously. This is particularly the case with the pneumococci, the minute dew-like colonies of which are easily recognizable. As a rule smear cover-slip preparations from the more marked lesions were also made. In some cases inoculations of animals with pure cultures of the bacteria found were made. No anærobic cultures were made. Little or no attention was paid to colon bacilli. In only one case in which they were found alone is their presence mentioned. In cultures made at autopsy they are found so commonly and in such diverse conditions, with or without lesions, and accompanying bacteria which may be regarded as the cause of the lesions, that we are disposed to consider them as having no specific and probably no pathogenic properties. They probably enter the tissues from the alimentary canal immediately after death or just before, when the resistance of the tissues is diminished. Usually the bacteria found in the kidneys were simply as a part of a general septicæmia.

The organism most commonly found was the pneumococcus. This was found in nine cases. In three cases streptococci were found, staphylococci in one, colon in one without

any accompanying organisms; in two the cultures were sterile. Of the sterile cases the kidney lesion in one followed acute articular rheumatism, and in the other the condition in the kidney was not accompanied by demonstrable lesions elsewhere. There was some general agreement between the character of the lesions and the sort of bacterium present. The most typical cases of the intra-capillary glomerular lesions accompanied the pneumococcus infections. In the streptococcus infections leucocytes entered more prominently into the process and there was more of the acute interstitial change. In the single staphylococcus infection the hyaline thrombi in the glomeruli were most prominent.

ACCOMPANYING ACUTE LESIONS.

Endocarditis was present in nine cases; eight of these were due to pneumococci and one to streptococci. The endocarditis was acute and usually of the ulcerative form. In most cases the lesion was primary, and in a few represented an acute form engrafted on an old. There is a well-marked relation between the pneumococcus endocarditis and that form of glomerular nephritis in which the intracapillary lesions are most prominent. In our earlier investigations so many cases of acute endocarditis were found with intracapillary lesions that we were disposed to consider pneumococcus endocarditis as the accompanying lesion. The pneumococcus has been present in the form of a general septicæmia in practically all cases in which it was found. In the City Hospital of Boston, acute pneumococcus pneumonia forms a large proportion of the autopsy material. Glomerular nephritis has been found to accompany the pneumonia in but one case, and in this, both from the character of the lesions in the kidney and from the clinical history, it was evident that the kidney lesion was primary. Pneumonia in the form of interlobular pneumonia with abscesses due to staphylococci was found in one case.

Erysipelas with streptococcus infection was found in one case; measles in two; syphilis with the constantly accompanying streptococcus infection in two, one of which was combined with measles. Acute articular rheumatism in

one; acute streptococcus infection following abortion in one; scarlet fever in one; diphtheria in one; gonorrhœa in one. In eight cases the presence or absence of an acute accompanying infection could not be ascertained.

ŒDEMA.

The presence or absence of œdema was noted in 14 cases. Of these it was present in 10. In 7 of these cases there was acute endocarditis with extensive valvular lesions. In 1 there was erysipelas, and in 1 acute articular rheumatism.

SUBACUTE AND CHRONIC GLOMERULAR NEPHRITIS.

Case I. — Man, aged 26. Pedler by occupation. Individual accustomed to drink. According to history his present illness began in January, 1893. At this time he says he caught cold, and there was considerable cough with mucopurulent expectoration. In March he noticed swelling of face which extended in two weeks over entire body, associated with loss of strength and dyspnœa. Three weeks later the urine was scanty, darker than usual. Occasional attacks of nausea and vomiting supervened. The urine was scanty during the entire residence in hospital. Large amount of albumen, much sediment, consisting of hyaline and granular casts, occasional blood corpuscles. Fatty degenerated epitheljum which was sometimes adherent to casts was found.

Autopsy, May 6th.

At autopsy there was extensive general œdema. Dropsy in all the serous cavities.

Heart slightly enlarged. No lesion of the valves.

Kidneys slightly smaller than normal. Weight not given. Capsule easily pulled off, leaving smooth surface with fœtal markings. Consistency of tissue increased. Pyramids distinct from cortex. The cortex was mottled with yellowish and opaque lines and more or less translucent spots and areas. The pyramids are shorter and also contain opaque yellowish spots. No examination made of fresh kidney.

The kidney was hardened in alcohol. In all of the glomeruli there are lesions which in some are more marked than

in others. Most of the glomeruli are larger than normal. Some are much smaller. In all the lobulation of the glomerulus is well marked. It does not present, as the normal glomerulus, a more or less connected mass of vessels, but it is divided into definite lobules, the divisions between which extend to the root of the glomerulus.

Fig. X. — Sections of portions of a glomerulus, showing hyaline degeneration, from Case I.

The different lobules in some of the glomeruli present different lesions. In some of them there is a considerable increase in the cells, and the lesions are comparable to those in acute glomerular nephropathy. In these the capillaries can be more or less definitely made out, and the cells in most cases lie within the lumen. The most marked change in the glomeruli is the conversion of the tissue into hyaline masses. This hyaline tissue stains brightly with eosin, and in the specimen stained with saffranin takes a slight bluish or lilac hue. (Fig. X.) In these hyaline masses the capillaries are entirely obliterated, or only here and there a few open vessels can be made out. The number of nuclei in the hyaline tissue varies. In some places the nuclei are very numerous, in others the nuclei are fewer and there is considerable nuclear detritus. Here and there in the tissue leucocytes can be made out. The formation of hyaline seems to take place in two ways, and the process can be followed in those places where the change is not so marked. It apparently takes place by the formation of hyaline between and within the vessels. Single blood-vessels can be made out with definite hyaline degeneration of their walls. (Fig. X.) There is slight thickening of the wall of the capsule by connective

tissue formation, and in places a slight growth of the capsular epithelium. The connective tissue is generally and diffusely thickened. Sections stained with the Van Geisen stain show an increased number of fibres. There is some increase in the number of cells. There is more or less degeneration in almost all the epithelium. There is probably considerable fatty degeneration, but this could not be positively ascertained owing to the method of hardening employed and the absence of fresh examinations. Some of the collecting tubules contained numbers of desquamated epithelial cells, both singly and in adherent masses.

Case II. — Girl, aged 16.

Patient was in hospital with acute rheumatism from September 28 to October 27, when she was discharged to the Convalescents' Home. October 30, readmitted into hospital. Two weeks before admission, hands, wrists, and knees began to swell and were stiff, but not painful. Urine showed large amount of albumen, numbers of red blood corpuscles, a few hyaline and epithelial casts, some leucocytes and epithelium.

On the right side of lower jaw there was a swollen fluctuating area, which was opened and discharged thin pus. On November 3, chill. Blood count November 5 showed slight leucocytosis. December 26: delirious; grew progressively worse until the 29th, when she died.

Autopsy December 30.

Abscess of neck and axilla. Bed-sore over sacrum. Lungs œdematous, with areas of broncho-pneumonia.

Kidneys large, combined weight five hundred and ten grmms. Surface pale, moist, slightly mottled. On section, cortex enlarged, pale, and œdematous. A thin opaque fluid easily squeezed from cut surface. The glomeruli pale, scarcely visible. Markings of cortex obscure. Pyramids slightly congested. Slight ascites. Fresh examination of kidneys shows extensive fatty degeneration of epithelium.

Sections of kidney examined after hardening in alcohol and Zenker's fluid. At first sight with low power there seems to be less alteration in this kidney than in the others. With a low power the most obvious condition is the dila-

tation of the tubules and the alterations of the glomeruli. The epithelium of the tubules appears to be fairly well preserved. The cells are generally small and flattened. The tubules contain a large amount of granular material in which the sharply defined circular reticulum previously described is embedded. In some of the tubules the epithelium is greatly swollen and either granular or contains large hyaline masses. There is some desquamation of the epithelium. In places the tubules are much further apart than normal, and there is a very slight increase in the cells of the interstitial tissue. Few of the glomeruli are enlarged. The number of cells in them is not greatly increased, and lobulation is evident. In scarcely any of the glomeruli are normal capillaries filled with red blood corpuscles found. The lobulation of the glomeruli is well marked, and many of the lobules are completely converted into hyaline masses. The hyaline tissue contains a variable number of nuclei, many of which are shrunken.

In this case there seems to have been a very rapid conversion of the glomerular cells into hyaline.

On bacteriological examination streptococci are found in the abscess of neck and axilla, in blood, liver, lungs, and spleen. Kidneys sterile.

Case III. — Boy, age 12. Admitted into hospital March 6. Three years previous to admission had pneumonia. Three weeks before admission he was exposed to severe weather. Face and extremities began to swell at this time. The mother of the patient does not remember that the urine presented any abnormal change. The œdema became so severe that the child was kept in bed. On admission, face pale with considerable œdema. Abdomen much distended; walls tense and œdematous. Examination of urine on March 7 showed many hyaline fine and coarse granular and epithelial casts and numerous hyaline refractive casts. A few leucocytes and round cells. One-eighth per cent. albumen. Examination of ascitic fluid showed eight-tenths per cent. albumen, many small and medium round cells, many of which were fatty. March 19,

examination of fluid withdrawn from abdomen shows same condition.

Amount of urine passed March	7	.	.	360 cc.
" " " "	9	.	.	440 cc.
" " " "	10	.	.	510 cc.
" " " "	11	.	.	250 cc.
" " " "	12	.	.	510 cc.
" " " "	13	.	.	420 cc.
" " " "	14	.	.	660 cc.
" " " "	15	.	.	450 cc.

The amount of urine from this time diminished greatly until death.

Autopsy March 18, 1895.

Legs and scrotum very œdematous. Abdominal cavity contains considerable light-yellow opaque fluid. Large amount of fluid in each pleural cavity.

Both kidneys weigh together 350 grmms. Both of same size and general appearance. Capsule easily stripped off, leaving smooth surface. Surface pale with ill-defined more hyperæmic areas. On section, cortex opaque, almost white. The glomeruli visible and pale. Pyramids congested. No frozen sections made.

Tissues hardened in corrosive. With low power the glomeruli are not very conspicuous. There is no dilatation of the tubules; on the contrary they seem to be somewhat smaller than normal. The whole tissue is denser and the interstitial tissue greatly increased. The glomeruli are about the size of glomeruli of an adult kidney. On examination with high power there is a marked increase in the cells in the glomerulus. There is considerable injection of the kidney in various places, and the red blood corpuscles are beautifully preserved and brightly stained with eosin. Only here and there in a glomerulus can any red blood corpuscles be seen. The lobulation of the glomerulus is very evident. In some of the glomeruli there is a large increase in the number of cells and a condition more or less resembling the acute intracapillary form is seen. In these places numbers of cells within the capillaries can be made

out. In general, however, the capillaries are reduced to very small channels in the hyaline tissue. Here and there capillaries are found filled with a more or less reticular mass somewhat resembling fibrin, but not giving the fibrin stain, among which cells are seen. Not only single lobules of the glomerulus, but entire glomeruli are converted into hyaline material. Leucocytes appear to take little or no part in the process. The intertubular tissue is everywhere thickened. It contains large numbers of cells similar to connective tissue corpuscles, and among these there are a small number of leucocytes. The tubular epithelium is small and atrophic. There is scarcely any distinction between the convoluted and the collecting tubules. Many of the cells are necrotic. The nuclei of these stain homogeneously and are small and angular. The swelling of the epithelium and the granular and hyaline degeneration are almost completely absent. Leucocytes are found in some of the tubules, granular detritus, and casts.

Cultures from the blood and all the organs sterile.

Case IV. — Man, aged 35. Said to have had rheumatism four years before death. Present illness began two months before death. Signs of cardiac lesion. Urine diminished in amount; large trace of albumen.

Autopsy. — General œdema. Purpuric hemorrhages over various parts of the body.

Heart, weight 425 grmms. Congenital opening into intraventricular septum. Acute endocarditis of mitral and aortic valves.

Kidneys, weight together 410 grmms. Capsule easily stripped off, surface beneath capsule pale and mottled. Stellate veins injected. On section, pyramids injected. Cortex increased in width, of opaque, grayish-white color. Glomeruli visible, pale. Markings of kidney obscure.

With low power the glomeruli are conspicuous by their large size. In most cases they completely fill the capsule. There is an increase in the number of cells of almost all of the glomeruli. The lobulation is very evident. The number of the lobes vary. (Fig. XI.) In some glomeruli, on cross-section, there appear to be as many as six or eight distinct

lobes; in others the glomerulus appears to be separated into two parts. The lobulation in most cases extends down to the root of the glomerulus. A very few of the glomeruli show no such lobulation, but the entire glomerulus is converted into a more or less obscure mass in which there are numbers of nuclei generally shrunken, and between them there is a large amount of more or less granular or hyaline material in which only here and there a small capillary opening can be made out. In some of the glomeruli single, greatly dilated capillaries can be found. In most of the glomeruli the tissue is converted into hyaline or faintly granular masses in

FIG. XI. — Section showing portion of glomerulus from Case IV. The lobulation is very evident. Most of the tissue is converted into hyaline. The open spaces in the tissue represent the still open vessels. 1-12 immer.

which only here and there a small distorted capillary lumen can be recognized. Occasionally in a well-isolated loop of the glomerulus blood-vessels can be found with a definite hyaline thickening of the wall, leaving but a small lumen. The nuclei within the glomeruli vary in character. The protoplasm about them cannot be distinguished from the tissue. Some of them are round or oblong. Numbers of small, very much shrunken and irregular angular nuclei are found in the hyaline tissue. Around a few of the glomeruli there is a well-marked thickening of the capsule and proliferation of the capsular epithelium. There is a general diffuse increase of connective tissue throughout the kidney,

in some places more extensive than in others. There is a very slight increase in the number of cells in the interstitial tissue. In various places in the interstitial tissue there are leucocytes both within and without the vessels. The epithelium shows a varying degree of degeneration. The tubules in general are somewhat dilated. The epithelium in places shows various degrees of degeneration; in places it

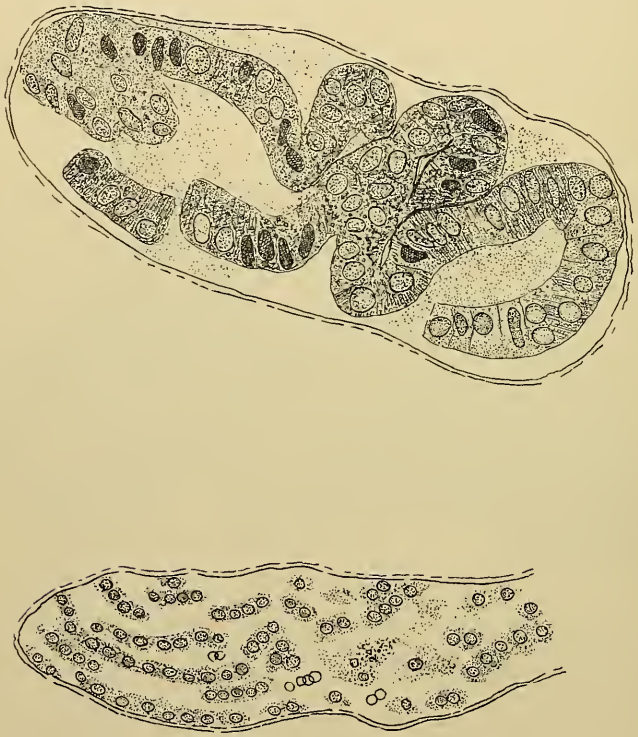


Fig. XII.— Large and small collecting tubules from Case IV. The large collecting tubule above contains a folded mass of epithelium which has been stripped off *en masse*. Many of the cells are necrotic and stain homogeneously. The tubule below is dilated, and contains single and adherent masses of desquamated cells.

is simply small and atrophic. In some tubules the epithelium is enormously swollen, filling up almost completely the lumen. The cells are pale and filled with round hyaline granules. (Fig. XII.) The lumen often contains the same material. There is considerable desquamation, and tubules filled with desquamated cells and *débris* of such cells with an occasional nucleus are found.

The body in this case had been injected by an undertaker. Cultures were made from the organs into which the undertaker's fluid did not appear to have penetrated. These were all sterile. A very careful examination of the skin was made with the view of determining whether changes in any degree analogous to those of the glomerular vessels could be found. Foci of hemorrhage were found around the vessels, but there were no definite lesions of capillaries.

Case V. — Woman, aged 18. Admitted to hospital August 14. Complained of dropsy and drowsiness. No complete history obtainable from patient. Dropsy said to have begun three weeks before entry into hospital. There was general anasarca, skin dry and harsh. Breath of urinous odor. Marked dyspnœa; pupils contracted. The urine, which was passed involuntarily in small amounts, contained much albumen, much *débris*, a few fatty and epithelial casts and fat-cells. August 17, condition continued. Patient passed small amount of urine in bed. Died comatose, August 19.

Autopsy. — General œdema; dropsy in serous cavities.

Kidneys of same size and general appearance. Both enlarged, combined weight 380 grmms. Capsule stripped off readily. Surface in general smooth, but presents several depressed reddish patches of atrophy. Color of surface pale-white, with opaque yellowish foci and points of hyperæmia and ecchymoses. On section, cortex mottled, pale-white. Markings obscure. Width of cortex 7 mm.

Kidneys hardened in Muller's fluid. Glomeruli very large, cells greatly increased. Lobulation, marked hyaline degeneration of groups of capillaries. In this case there is an extreme degree of proliferation of the capsular epithelium. In some of the glomeruli there is well-marked hyaline atrophy, with masses of epithelial cells penetrating between the atrophic vessels. In the epithelial masses in the capsule there are some definite spaces which appear to be lined with more or less cuboidal epithelium. There are large numbers of cells more or less crescentic in shape in the tubules leading off from the glomeruli. (Fig. XIII.) These cells appear in part to be derived from the epithelium of the capsule, and

in part from desquamation of cells in the tubules. The tubules are dilated, and the epithelium covering them flattened. In places there is extensive desquamation of the epithelium. Some of the tubules contain masses of cells, and in others there is a large amount of hyaline detritus. Throughout the cortex there is a general increase in the connective tissue. Leucocytes are found in the connective tissue, and in the tubules in slight numbers. In places in the

FIG. XIII.—Section from Case V., showing peculiar crescentic-shaped cells in the tubules. The intertubular spaces are dilated. In the lower right-hand tubule there is considerable hyaline. Zeiss D.

interstitial tissue there are large cells similar to those described in the interstitial nephritis.

In the following cases specimens of the kidney alone have been preserved without any clinical reference:

Case VI. — Labelled "Large white kidney."

Weight and macroscopic appearance not given.

Typical glomerular change. Great increase of cells; lobulation; hyaline degeneration of capillary groups. Dilatation of tubules and intertubular tissue. Granulation and hyaline degeneration of tubular epithelium with necrosis

and desquamation. Some diffuse increase in connective tissue with slight increase in the number of cells. Few leucocytes in the tubules and in the connective tissue.

Case VII. — Labelled "Large white kidney."

Extensive glomerular lesions. Great increase in size; large number of cells; hyaline degeneration. Degeneration and desquamation of epithelium of tubules. Some dilatation of tubules and of intertubular tissue. Slight diffuse connective tissue increase.

Case VIII. — Labelled "White kidney of normal size."

Extensive lobulation and hyaline degeneration of glomeruli. General increase in connective tissue. Hyaline and granular degeneration of epithelium of tubules; granular detritus and masses of epithelial cells in collecting tubules. No cellular increase in interstitial tissue. In places slight hemorrhage in tubules.

Case IX. — Labelled "Large white kidney with an unusually acute course."

Glomeruli very large, great increase of cells; typical lobulation, with hyaline degeneration and obliteration of vessels. Intense granular and hyaline degeneration and desquamation of epithelium. Dilatation of intertubular tissue. Slight increase of cells in the interstitial tissue.

Case X. — Labelled "Small white kidney." Dropsy.

In this kidney the glomeruli are for the most part converted into lobulated masses of hyaline tissue. In some of these there is a slight increase in the number of cells. In but a few of the glomeruli can distinct capillaries be made out. Here and there the capillary masses are adherent to the capsule. In one place vessels from the capsule can be seen to pass into the glomerulus.

Case XI. — Labelled "Beginning large white kidney."

In this case the lobulation of the glomerulus is well marked. There is great increase of cells with marked proliferation of capsule. Dilatation of intertubular tissue and

of tubules. Extensive degeneration of epithelium of tubules. No increase in connective tissue.

Case XII.—Labelled "Large white kidney." Lobulation and hyaline degeneration of glomeruli. Extensive degeneration and desquamation of tubules. Slight increase in connective tissue around glomeruli.

Case XIII.—Labelled "Subacute, beginning large white kidney."

Œdema. Lobulation and hyaline degeneration of glomeruli; in some places great increase in cells. Dilatation of intertubular tissue. In places considerable numbers of leucocytes in the intertubular tissue and in tubules. Fibrin in capsular space and in tubules.

REVIEW OF LESIONS.

This kidney has been known under various names: it is the large white kidney of Wilkes; the chronic parenchymatous nephritis of the Germans. There is no doubt but that the amyloid kidney was and still is frequently confounded with this, and without testing for amyloid they cannot be distinguished. In the amyloid kidney there is the same degeneration of the epithelium, due most probably to the same cause: disease of the glomerulus, interfering with the circulation through it. In the amyloid kidney the vessels of the glomeruli are occluded by amyloid deposit in the walls and between them. In the chronic glomerular nephritis the occlusion is brought about by hyaline degeneration. In both the duration of the process varies, and in both there may be extensive destruction of the parenchyma followed by general increase in the connective tissue. It is convenient to separate them by the presence of amyloid in the one, but in both apart from the amyloid the process is very similar.

In a review of the lesions of these cases the glomeruli claim our chief attention. Much that was said of the condition of the glomeruli in the acute glomerular nephritis is equally applicable here. Slight differences in the degree

of affection may be found in different glomeruli and in different parts of the same glomerulus. All of them show an increase in the number of cells. In places conditions resembling the acute forms are seen, the cells being greatly increased in number and lying for the most part within the capillaries. In some of the acute forms, notably in Cases XIX. and XXV., mention was made of hyaline degeneration with lobulation of the glomerulus; in the chronic these conditions are prominent. What we have described as lobulation of the glomerulus exists to some extent in the normal. The capillaries are somewhat divided into groups, and the covering epithelium dips down between them. This lobulation becomes more evident in some of the acute cases, and its presence marks the transition to the more chronic forms. The glomerulus is divided into a number of distinct lobules, the separation between them extending nearly down to the root. Sections crossing the glomerulus and root show usually four or six such lobules. In sections passing through the glomerulus in the other direction as many as eight distinct and separate masses may be found. With the lobulation hyaline degeneration advances. The hyaline degeneration appears first in the outlying capillary loops, those most distant from the root. At first only small portions become hyaline and by gradual extension whole lobules and even whole glomeruli are so altered. The hyaline material is homogeneous or in places finely granular, it stains brightly with eosin, and in alcoholic specimens stains a faint purplish or lilac hue with safranin. In the hyaline masses small spaces with here and there a red corpuscle or a leucocyte mark the vessels. Dilated vessels filled with blood corpuscles are occasionally found. In the most advanced degree of the degeneration nothing is seen but the solid hyaline mass. At first there seems to be no decrease in the number of nuclei. They are crowded together in the hyaline mass and show various differences in form and in staining. Most of them are irregular and elongated or granular, and stain homogeneously. The protoplasm of the cells belonging to them is merged into the hyaline mass. Very thin sections in places where the hyaline formation is not advanced enable us to gain some idea of its mode of formation.

Occasionally capillaries were found cut longitudinally in which the lumen was exceedingly small and irregular and the wall thickened apparently by a formation of hyaline on the inner wall of the vessel. Even here it is possible that the hyaline may have been formed on the outside. Distorted nuclei were found in the hyaline within the vessel. In other cases the hyaline seemed to be formed outside of the vessels. Nuclear detritis was found to some extent in the hyaline material.

All the cases in which fresh examinations were made or in which portions of the tissue were hardened in Flemming's solution showed considerable diffuse fatty degeneration.

The capsular epithelium in most cases shows some hyperplasia. Flattened epithelial cells derived from the capsule were found in the capsular space and between the lobules of the glomerulus. In some cases the growth is excessive, and sections passing at right-angles to the root of the glomerulus show the single groups of hyaline vessels completely surrounded by the epithelial masses. The nuclei in the epithelial cells are frequently irregular in form, and atrophic, and the cells converted into a more or less granular mass. In one specimen spaces were found among the epithelial cells, and around the spaces the cells were arranged in more or less cuboidal forms. Connective tissue formation to some degree takes part in the capsular change. Bands of connective tissue extend from the capsule into the epithelial cell masses more or less dividing them, and single connective tissue fibres were shown by the Van Gesen stain among the cells. There is no evidence of connective tissue formation from the capsular cells, but in all instances it seems to have grown into the mass from the connective tissue of the capsule. The connective tissue of the capsule was often thickened and the cells in it increased in number. The hyaline masses of the glomerulus are often found adherent to the capsule, and in one specimen there is a long projecting mass of connective tissue which extends from the capsule down to the root of the glomerulus, and which contains several wide vessels.

The epithelium of the tubules shows extensive degeneration, which does not differ materially in kind from that

described in the acute forms. The tubules are often dilated and filled with desquamated cells, hyaline material, and granular *débris*. In one case the epithelium of the dilated convoluted tubules is atrophic and the cells crescentic in form. The tubules in this case contain great numbers of these crescentic-shaped cells, which seem in part to be due to desquamation from the tubules and in part to have come from the glomerular capsules in which there was extensive hyperplasia. Hyaline degeneration of the epithelium was formed in every case.

There is a varying degree of involvement of the connective tissue of the kidneys. It is always slightly increased, and in the more chronic cases there is a general growth extending diffusely throughout the tissue. The diffuseness of this connective tissue formation explains the absence of granular contraction of the surface, even though the kidney as a whole is atrophied.

That the subacute and chronic glomerular nephritis represents a more chronic condition of lesions of the same character as those found in the acute form is evident. In both the glomerular changes are the most striking lesions. Changes similar to the acute, consisting in increase of cells in the capillaries, hyperplasia of the capsular epithelium, are found in the chronic. In the chronic there is a further hyaline degeneration, partly from a conversion of the cells into hyaline, partly from hyaline degeneration of the walls of the vessels, followed by contraction by which the lobulation becomes pronounced. The degree of the connective tissue formation seems proportionate to the degree of epithelial degeneration and desquamation, and probably follows it.

ACUTE INTERSTITIAL NEPHRITIS.

This form of kidney disease was first described by Wagner (D. Arch. Vol. 25) under the name of acute lymphomatous nephritis, and he makes it one of the four forms of Bright's disease. He says it is most frequently found in scarlet fever, but may also be found in typhoid. The kidneys are enlarged, pale, and brittle, hemorrhage may be present in slight degree or entirely absent. The most characteristic

lesion is accumulations of round cells of various size which are most numerous around the glomeruli. Others have described these lesions in the interstitial tissue, but they have not been regarded as the essential lesion in an anatomical type of renal disease. Orth has an interesting description of the process (Lehrbuch, Vol. 2, p. 75). He says he has seen kidneys in which there were no, or very slight, lesions of the epithelium and in the glomeruli, but in which there was a small cell infiltration in the interstitial tissue. He describes such kidneys as large and pale. Regarding the origin of the cells he says the cells have a large, round, vesicular nucleus and differ from the ordinary emigrated leucocytes. He thinks they may be derived from proliferation of the tissue cells, though their position around the veins would show that emigration also plays a part in their production.

Case I. — Child, aged 8, admitted January 19, with scarlet fever. No œdema. Intense congestion of pharynx. Over skin typical scarlet-fever eruption. Died same day. No examination of urine.

Autopsy. — There was general hyperæmia of skin with slight desquamation of cervical region and over thighs; redness most marked over legs and in cervical region. Mucous membrane of pharynx intensely congested. On left side an ulcer involving the tonsils and extending into the tissue beyond. On the right side a small abscess. The pharynx and epiglottis swollen and intensely congested. No membrane formation.

Broncho-pneumonia of both lungs. General hyperplasia of lymphatic tissue all over the body.

Both kidneys of same size and general appearance. Both slightly enlarged. Weight not given. Capsule easily stripped off. Surface of cortex pale, mottled, opaque, with slight hyperæmic areas. On section, cortex slightly increased in thickness, pale, markings obscure; pyramids apparently normal.

Microscopic examination of kidneys fresh shows a diffuse fatty degeneration of the epithelium and intense round-cell infiltration in the intermediate zone and in foci throughout the cortex, and especially about the glomeruli.

Portions of tissue hardened in Flemming's solution and in alcohol. Sections of tissue made after embedding in paraffin and celloidin.

On examination with low power the most striking condition is the infiltration of the tissue with cells. At first this was considered to be purulent infiltration. On closer examination the cells are of a different character from pus cells. They are large, usually with a single large nucleus, and con-

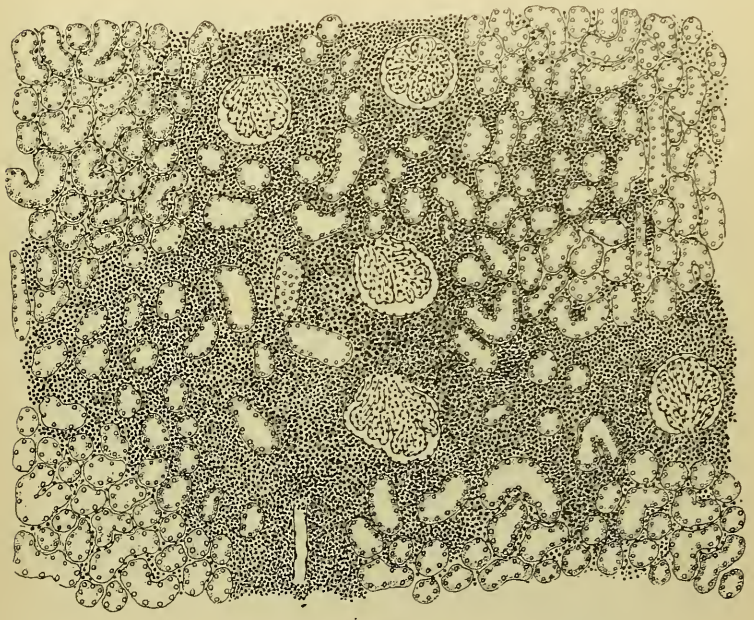


FIG. XIV. — Section of kidney from Case I., showing interstitial infiltration. Zeiss A.

siderable protoplasm. The cells are chiefly found in the intermediate zone of the kidney, from which they extend into the cortex. Throughout the cortex there is a slight general infiltration of the interstitial tissue, with cells and a more or less focal infiltration chiefly around the glomeruli. (Fig. XIV.) There is no alteration in the glomeruli, either of the vessels or the capsule. In addition to the fatty degeneration shown in the fresh sections the hardened sections show considerable cloudy swelling with some hyaline degeneration. The epithelial degeneration is more prominent in the areas of cellular infiltration than elsewhere. A careful

search of the sections hardened in alcohol fails to show any bacteria in the kidney.

Microscopic examination of the pus from abscess shows large numbers of streptococci and pneumococci with capsules. Cultures from all the organs show general streptococcus septicæmia.

Case II. — Child, aged 8. Admitted into hospital January 14, 1893.

Well-marked scarlet-fever rash. Intense hyperæmia, with slight membrane in pharynx and fauces. No examination of urine recorded. Child died suddenly on the 20th.

Autopsy. — Intense hyperæmia of skin, with slight desquamation of cervical region. No œdema. There is hyperæmia with slight ulceration in the pharynx which does not extend deeply into the tissues, and appears rather as an erosion than ulceration. In the midst of the eroded tissue there are small areas of normal mucous membrane. Bronchitis and broncho-pneumonia. Caseation of lower cervical and bronchial lymph glands.

Kidneys greatly enlarged. Combined weight, 400 grmms. Capsule stretched and distended. On section the swollen kidney separates voluntarily from the tense capsule. The capsule is congested and sprinkled with small hemorrhages. The surface of the kidney mottled, with some areas of congestion. On section, cortex is greatly thickened, averaging 10 to 12 mm. Pyramids slightly enlarged. In cortex there are reddish streaks extending to the surface, and between these large whitish opaque streaks and circumscribed opaque areas. The kidney much moister than normal. Malpighian bodies not visible.

Fresh frozen sections show slight fatty degeneration and general cellular infiltration of interstitial tissue.

Portions of kidney were hardened in alcohol and Flemming's solution.

With low power the sections show a general increase of cells throughout the intermediate zone of kidney extending into cortex. In places these cells are so numerous as to obscure the other details of the tissue. The tubules where the cells are most numerous are compressed and atrophied.

These cells are everywhere in the interstitial tissue. The cells are large, in many cases the size of epithelial cells. They can be distinguished always from the epithelium by the character of the nucleus, which is round, more solid, and stains more brightly than do the nuclei of the epithelium. The chromatin granulation of the nucleus is coarser than in the epithelium, and distinct threads can be seen connecting

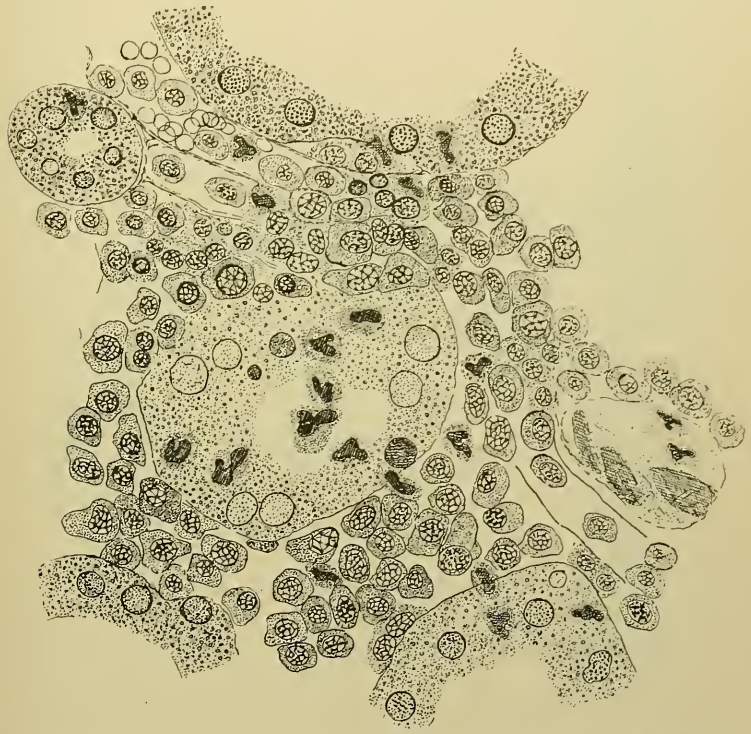


FIG. XV. — Section showing interstitial infiltration. The large cells in the interstitial tissue are easily distinguished from the leucocytes, which are partly in the tubules and in the interstitial tissue. 1-12 immer. camera drawing.

the granules with one another. (Fig. XV.) In various places in the interstitial tissue there are dilated capillaries filled with red blood corpuscles, and in these the large cells can be found in considerable numbers. Most of the cells are fully twice as large as the polynuclear leucocytes. In addition to these very large cells there are smaller cells similar to lymphoid cells. It is only when the cells are few in number that these characteristics can be distinguished.

(Fig. XVI.) Where they are most numerous they fill up the entire tissue, and are so closely pressed together that the protoplasm of the individual cells can no longer be seen. Here and there in the tissue capillaries are seen in which the nuclei of the endothelium are greatly swollen.

FIG. XVI.—Single vessels from interstitial tissue, showing large cells in the lumen. 1-12 immer.

A careful search was made for nuclear figures, but these were not found either in the cells of the capillaries or in the large cells. The large cells within the vessels are occasionally found adherent to the wall, and various transitions can be seen between what are evidently swollen endothelial cells and the large cells. In the cortex of the kidney there is a slight general infiltration of the interstitial tissue, but

the cellular infiltration is chiefly marked around the glomeruli. Around the glomeruli and in the interstitial tissue of the cortex capillaries are found with the large cells in the lumen. Among the large cells a few leucocytes can be distinguished, and in the tubules which they surround leucocytes are often found in and among the necrotic epithelial cells.

In the sections of the larger veins of the kidney these large cells are occasionally found. There is no increase in

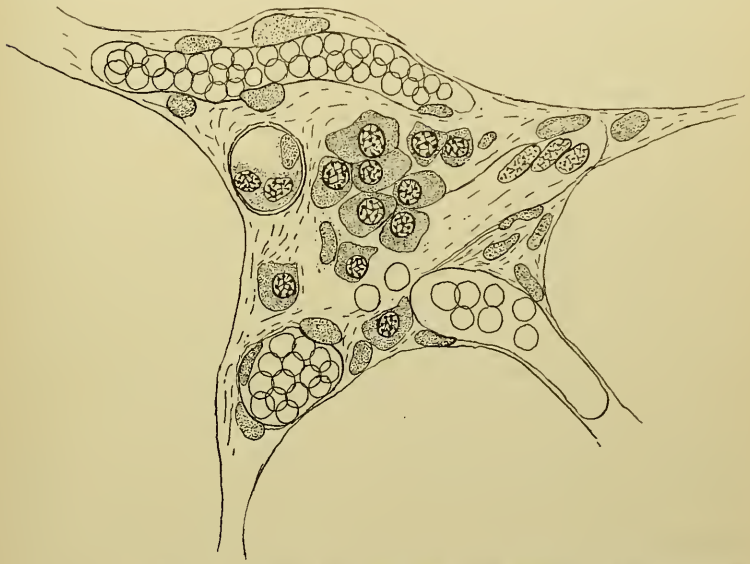


Fig. XVII. — Section from arterio-sclerotic kidney, showing cells of the same character as those in the acute interstitial. 1-12 immer.

the fibrillar interstitial tissue, but in places the tubules are slightly separated from one another by a loose, apparently œdematous, interstitial tissue.

Examination of alcohol sections for bacteria failed to reveal any. (Fig. XVII.)

Cultures show a general streptococcus infection, with the exception of the kidney, cultures from which were negative.

Case III. — Woman, aged 30. Patient came to hospital two weeks before death, having aborted one week before entry. At the time of entry, foul discharge from vagina. Uterus curetted. Patient died one week after operation.

No examination of urine recorded.

Autopsy. — No œdema. Heart not enlarged. Along the tricuspid valve there is a marked acute endocarditis. Commencing at the edges of the valves there is acute swelling and purulent infiltration producing flat elevations extending some distance upon the valves. The cordæ tendinæ are swollen, whitish, and at the insertion of the cordæ into one of the papillary muscles there is a purulent infiltration with beginning ulceration.

The kidneys large, combined weight 410 grmms. Capsule stripped off. Surface somewhat mottled, with areas of intense congestion and small ecchymoses. On section, cortex averages 1 cm. in width. Glomeruli not visible. Markings obscure. Cortex very opaque and cloudy. Pyramids injected.

Kidneys hardened in alcohol and corrosive. There are no lesions of the glomeruli. In the epithelium there is granular and hyaline degeneration. No marked destruction of epithelium. In the cortex there are only a few foci of cellular infiltration. In the upper portion of the pyramids, and in the intermediate zone of the kidney, there is well-marked infiltration. The cells in this are not so numerous as in Case II., and their situation and character can be better studied. The cells are evidently in large part in the capillaries and small veins. The epithelium of the tubules surrounded by these cells is degenerated and in part destroyed.

Case IV. — Child, aged 6. Admitted into hospital November 23, 1892. Diphtheria.

The urine examined on admission showed no albumen.

December 4, large gland on right side of neck suppurated, and was opened. Further operation December 12. No examination of urine after admission.

Autopsy December 15. No œdema. Incised wound of neck on right side 4 cm. in length. Edges indurated. This opens into abscess cavity 3 cm. in diameter, irregular in outline; covered with yellowish membrane. Small incised wound at angle of left jaw opening into a smaller cavity containing pus. Crusts about nares and lips with small hemorrhages. Ulceration of both tonsils and pharynx.

Firmly adherent fibrinous exudation over pharynx wall and epiglottis. Broncho-pneumonia and atelectasis of both lungs.

Kidneys enlarged, weight 305 grmms. Capsule peeled off readily, leaving a reddish opaque surface. On section, cortex thick with little contrast between it and pyramids. Markings indistinct. Glomeruli not visible. Numerous small hemorrhages.

Microscopic examination shows no lesions of glomeruli. Well-marked cellular infiltration in interstitial tissue. Slight degeneration of epithelium, small foci of hemorrhage throughout cortex.

Examination of pus from abscess of neck shows streptococci.

No cultures were made of organs.

Case V. — Patient, child, aged 11, admitted into hospital two days before death. Well-marked septic diphtheria. No examination of urine recorded.

Autopsy November 16, 1894.

No œdema. Body very small, emaciated, pale. On face and vicinity of nostrils small superficial excoriations covered with dark crusts. Ulceration and diphtheritic membrane in pharynx and over epiglottis. Bronchitis and broncho-pneumonia of both lungs.

Kidneys large, weight 370 grmms. Capsule stripped off easily. Surface grayish, congested, in places mottled. On section, cortex wide; markings obscure. Pyramids not well marked. Tissue succulent. Tissues hardened in alcohol and corrosive.

No lesions of glomeruli. Slight dilatation of tubules. Well-marked interstitial infiltration extending diffusely throughout cortex and in intermediate zone. The process is not so extensive as in other cases, but the character of the cells and their situation, partly within the blood-vessels and partly outside of them, is clearly shown. The epithelium throughout the kidney is swollen, granular, and in part hyaline.

Case VI. — Kidney from case of scarlet fever. No record of clinical history or autopsy.

There is no change in the glomeruli. There is very general and diffuse increase in the cells in the interstitial tissue of the kidney everywhere throughout the cortex. There is no increased connective tissue formation, and the cells are of the same character as those previously described. There is one marked difference in this case from the others, in that in a large accumulation of the interstitial cells near the cortex of the kidney there is a giant cell. This is the only case in which giant cell formation was found among the interstitial cells. There is no necrosis in the vicinity of the giant cell and no evidence of tuberculosis. The epithelium of the kidney shows extensive granular and hyaline degeneration, is slightly necrotic in places, and desquamated.

Case VII. — Kidney from unknown source. There is no change in the glomeruli. Throughout the cortex of the kidney there is an infiltration with cells. From the size of the glomeruli the kidney is evidently from a child. The distribution of the cells in the cortex is somewhat irregular; in places they are extremely abundant, in others comparatively few. Owing to the manner of hardening, the exact character of the cells of the tissue cannot be made out. There is no increase in the fibrillar connective tissue. The epithelium shows various degrees of degeneration.

Case VIII. — Kidney of unknown origin. No clinical history or autopsy report.

The tissue has been hardened in Muller's fluid and stained with hæmatoxylin and eosin.

Throughout the kidney there are smaller and larger foci of the interstitial cellular infiltration in the cortex, chiefly around the glomeruli. The nuclei of the cells of the interstitial tissue are stained brightly. They are of the same character as those previously described. Many of the cells contain two nuclei. The epithelium of the tubules is degenerated, and in places, especially in the midst of the cellular infiltration, the cells are distinctly necrotic.

REVIEW OF LESIONS.

This form of nephritis evidently deserves the name which has been applied to it. The essential lesions are in the interstitial tissue, and from the character of the lesions, and from the character of the newly formed cells, it is evident that they cannot be considered as secondary to a primary epithelial degeneration. While there is no doubt that lesions of the parenchyma of a tissue when they are sufficiently extensive, and when long enough time elapses, will be followed by a growth of interstitial tissue which has the effect of making good the loss, there is equally no doubt that there can be primary lesions of the interstitial tissue. The cells in this case are in a way similar to those seen in acute hyperplasia of the connective tissue cells, particularly those of the walls of the blood-vessels, occurring under other conditions. Similar cells to these may be found in rapid proliferation of the subcutaneous connective tissue in the vicinity of wounds, and it is probable that they have the same origin. The cells seem in large part to come from the endothelium of the blood-vessels, the small veins, and capillaries. So far as we have been able to see, the arterial endothelium takes no part in the process. In other pathological conditions in other organs, especially in the meninges, proliferative changes in the arterial endothelium are not uncommon. While these cells are by no means confined to the intermediate zone of the kidney, they seem to be more numerous here than close beneath the capsule. There is both a general and a focal increase in the number of cells. The focal increase is by no means sharp and distinct, and is chiefly found around the glomeruli extending from this into the surrounding intertubular tissue.

The cells of the connective tissue capsule of the glomeruli and the capillaries around this take part in the process. Among these cells leucocytes are present in variable numbers, and the process is probably accompanied by emigration. The leucocytes are found both in the interstitial tissue between these cells and in the degenerated and necrotic epithelium of the tubules in their midst, and in the lumen of these tubules. None of the large cells were ever found

within the tubules. In all of the cases there is more or less degeneration of the epithelium, most marked where the interstitial cellular infiltration is most prominent. Elsewhere throughout the kidney the degeneration, though present, is not so marked. In those cases in which fresh examinations were made, fatty degeneration was found. In none of the cases are the glomeruli affected. The degeneration of the tubular epithelium in the interstitial infiltration may be partly due to the pressure exerted by the masses of cells. It is to be regretted that there is no report of the examination of urine, but it is probable that this condition of the kidney may exist with but little alteration of the urine during life.

In these cases we must assume the presence of a toxic material which exerts its action on the two constituents of the kidney tissue, which at the same time leads to the degeneration of the parenchyma and proliferation of the interstitial tissue.

Bacteriological examination was made in but four cases, and in all of these streptococcus infection was found. The associate disease was ascertained in six cases. In three of these there was scarlet fever, in two diphtheria, and in one endocarditis following abortion. Five out of the six cases occurred in children. In none of the cases was there œdema.

ACUTE HEMORRHAGIC NEPHRITIS.

In this the chief lesions consist in hemorrhage accompanied by varying degrees of degeneration of the epithelium. Only three cases were met with. Two of these were from typhoid fever, and one from a case of acute endocarditis with infectious pneumonia. The character of the pneumonia was not described, but it was probably embolic. The clinical history of none of the cases is given. The hemorrhages in these cases were added to acute degeneration. In most of the cases the hemorrhage appears to take place from the glomerulus. In one case there was extensive hemorrhage in the tubules without any change in the glomeruli.

Case I. — Typhoid fever. Large swollen kidney, capsule easily stripped off; numerous hemorrhages in the capsule. The surface of kidney congested. On section, cortex wide. Numerous small foci of hemorrhage.

On microscopic examination there are small hemorrhagic foci scattered throughout the kidney. A glomerulus is usually in or near the centre of each focus, and the tubules with hemorrhage seem to be those nearest to the glomerulus. Many of the glomeruli contain crescentic masses of blood coagulum and fibrin in the capsules. The amount of blood in the cortex varies. In some it is small, in others so large that the glomerulus is pressed to one side of the blood mass. There does not appear to be any hemorrhage within the glomerulus itself between the tufts of vessels. The tubules with hemorrhage are dilated. The epithelium is in part compressed and atrophic and in part hyaline. In other tubules the epithelium is swollen and granular, and in others there is an extreme degree of hyaline degeneration.

In the specimen hardened in Flemming's solution there is fatty degeneration confined to the smaller collecting tubules and the tubules of Henle. In a few places the tubules are separated by œdematous intertubular tissue in which there is cellular infiltration. The cells are large and similar to those in interstitial nephritis. In some of the collecting tubules there are masses of desquamated cells.

Examination of sections for bacteria was negative. No cultures were made at the autopsy.

Case II. — Kidney marked "Acute Bright's disease after typhoid."

Kidney swollen, congested, and hemorrhagic. In this case the hemorrhage in the tubules is more extensive than in the previous case. Only a few of the glomeruli were distinctly hemorrhagic. There are no lesions of the glomeruli. The epithelium, as in the preceding case, is extensively degenerated; the interstitial tissue is in places dilated, but there is no cellular infiltration.

Examination for bacteria negative. No cultures.

Case III. — Kidney marked " Case of acute endocarditis with infectious pneumonia."

The kidney large, pale, with numerous small hemorrhages.

On microscopic examination there is extensive hemorrhage, groups of tubules being filled with blood. Small amounts of blood are found in some of the capsules of the glomeruli. In a few places in the cortex of the kidney, chiefly around the glomeruli, there is an increase in the number of cells in the interstitial tissue. In the intermediate zone of the kidney there is also a slight increase. Leucocytes in very small numbers are found. There is marked swelling and granular degeneration of the epithelium, and in specimens hardened in Flemming's there is a small amount of fat. The tubules, especially those containing the blood, show marked granular and hyaline degeneration of the epithelium. The tubules are generally dilated. In addition to the cells the interstitial tissue shows slight œdema.

III.

A REPORT ON THE BACTERIOLOGICAL INVESTIGATIONS OF THREE HUNDRED AND TWELVE CASES OF SURGICAL INFECTION.

(From the Surgical Wards and Out-Patient Department of the Boston City Hospital.)

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In this paper, in addition to the bacteriological report, the results of the clinical study of the cases have been presented as far as possible. Two hundred and fifty cases were from the wards and sixty-two from the Surgical Out-Patient Department. The Out-Patient Department cases occurred from September 1 to December 1, 1895, and the ward cases from January 1, 1896, to December 31, 1896.

The work was carried on under the direction of Prof. W. T. Councilman, in the Pathological Laboratory of the Boston City Hospital.

METHODS OF STUDY.

The methods of study pursued were the same as those used by Wright and Stokes which they described at length in their report on the bacteriological investigations of autopsies, published in the sixth series of these reports.

Loeffler's blood serum mixture in slants (Dr. Mallory's modification) was used almost entirely. In the differentiation of typhoid and colon bacilli, and in several other cases, the usual special media were employed. In some of the cases inoculations of animals were also made.

Abscesses.

One hundred and fifteen cases examined, with the following results, the

Streptococcus pyogenes occurred 56 times.
Staphylococcus pyogenes aureus occurred 52 times.
Staphylococcus pyogenes albus occurred 29 times.
Bacillus pyocyaneus occurred 4 times.
Micrococcus lanceolatus occurred 2 times.
Bacillus diphtheriæ occurred 1 time.
Bacillus coli communis occurred 6 times.
Bacillus pyogenes fœtidus occurred 1 time.
Bacillus typhi abdominalis occurred 1 time.
Gonococcus occurred 1 time.
Amœba coli occurred 1 time.
Undetermined bacteria occurred 3 times.

Of these 115 cases 78 were caused by a single organism and 37 were due to a mixed infection. Of these 78 cases in which pure cultures were obtained the streptococcus occurred in 31; the staphylococcus aureus in 32; the staphylococcus albus in 8; the bacillus coli communis in 3; the bacillus typhi abdominalis in 1; the micrococcus lanceolatus (pneumococcus) in 1; gonococcus in 1, and the amœba coli in 1. Of the 37 cases of mixed infection the streptococcus occurred in 25; the staphylococcus aureus in 20; the staphylococcus albus in 21; the bacillus coli communis in 3; the bacillus pyocyaneus in 4; the bacillus diphtheriæ in 1; the bacillus pyogenes fœtidus in 1; the micrococcus lanceolatus in 1, and undetermined bacteria in 3.

It will be noticed that the streptococcus was found in these cases much more frequently than is usual in abscesses. In the pure infections the streptococcus occurred in 39 per cent., the staphylococcus aureus in only 41 per cent., and the albus in about 10 per cent. This large percentage of streptococcus can be accounted for partly by the fact that by far the greater number of these cases occurred in the wards. Usually abscesses due to the staphylococci are of a milder nature so that they can be treated in the Out-Patient Department; consequently it would be expected that in the cases severe enough to warrant admission to the hospital there would occur a relatively higher percentage of streptococci. That such is the fact will be seen by a study of the following cases: Of the 78 pure infections 18 occurred in Out-Patient Department and 60 in the wards. Of the

18 out-patient cases the staphylococcus aureus occurred in 13; the staphylococcus albus in 4, and the streptococcus in 1.

Of the 60 ward cases the aureus occurred in 20, the albus in 4, and the streptococcus in 30. In the out-patient cases it will be seen that only a little over 5 per cent. were due to the streptococcus, while in the ward cases the streptococcus occurred in 50 per cent.

Of the 37 cases of mixed infection 5 were out-patient and 32 ward cases. In the 5 out-patient cases the streptococcus occurred twice, the albus twice, and the aureus once.

In the 32 ward cases the streptococcus occurred in 23, the aureus in 18, and the albus in 19. The mixed infections show also a relatively high percentage of streptococci in the ward cases, about 72 per cent., while the out-patient cases show 40 per cent. The combination of the mixed infections in which the streptococcus occurred are as follows: Streptococcus with aureus, 11; with albus, 8; with the diphtheria bacillus, 1; with other bacteria, 5. The mixed infections were as a rule more severe than the pure infections. Occasionally, however, the different bacteria antagonize one another in mixed infections, producing a milder inflammation. The combination of the streptococcus and aureus produced the most severe symptoms.

Of the cases of abscess in which other than the staphylococci and streptococci occurred there were a number which are deserving of mention. The diphtheria bacillus occurred once, with the streptococcus in an abscess of the back following antitoxin injection. This abscess showed no special features and healed readily. The colon bacillus was found 3 times in mixed cultures. The pure cultures were from abscesses of gall-bladder, kidney, and pelvis. The mixed cultures were obtained from 3 pelvic abscesses.

The typhoid bacillus was found once in pure culture in an abscess of the gall-bladder. The gonococcus occurred once in a labial abscess. The amœba coli was found pure in a case of liver abscess.

The pyocyaneus occurred in 4 cases, but in each instance with one or more of the pyogenic cocci.

The three cases of abscess due to the colon alone were mild. The abscess of the kidney due to colon bacilli discharged for a long time. In this case, however, there was a mixed infection after operation. The wound could not be closed, and the drainage opening gave entrance to the pyogenic cocci.

Of the rarer abscesses that of the gall-bladder due to the typhoid bacillus is worthy of note. This abscess occurred in the third week of typhoid fever. The patient at the time was in too precarious a condition for surgical interference. The abscess was aspirated by Dr. A. L. Mason, and about 3 or 4 ounces of purulent fluid withdrawn, from which cultures were made. The patient made good recovery, and was discharged after the usual time of typhoid convalescence.

The case of abscess of the liver due to the amœba coli is uncommon in this part of the country. Cultures from abscess showed no growth of bacteria. The diagnosis of the presence of amœba coli was made by fresh examination.

Carbuncles.

Three cases. In each case the staphylococcus aureus was obtained in pure culture.

Pustules.

Six cases. All pure infections; the staphylococcus aureus occurred in 4; the bacillus diphtheriæ in 1; and the bacillus pyocyaneus in 1.

Furunculosis.

Six cases (pure infections). The aureus occurred in 4; the streptococcus in 1; and the pyocyaneus in 1.

Felons.

Three cases of pure infection. The aureus occurred in each case.

Malignant Pustule.

One case in which the staphylococcus citreus was found with the anthrax bacillus. This case will be reported fully under mixed infections.

Cellulitis.

Thirty-five cases, of which 17 were pure infections and 18 mixed infections. The streptococcus was found in 19: the aureus in 16; the albus in 7: the pyocyaneus in 3; the micrococcus lanceolatus in 2; the megatherium bacillus in 1: and undetermined bacilli in 2.

Of the 17 pure infections the streptococcus occurred in 9; the aureus in 6; and the micrococcus lanceolatus in 2. In the 18 mixed infections the streptococcus occurred 10 times: 5 times with the aureus, 3 times with the albus, once with the pyocyaneus, and once with the albus and pyocyaneus. Of the remaining 8 cases of mixed infection the megatherium and albus occurred once, the albus and aureus in 2, the aureus and pyocyaneus in 1, and the aureus and undetermined bacilli in 2.

In the pure infections the streptococcus produced the more marked symptoms with slower recoveries. Those due to the aureus were as a rule of milder character, though in several the symptoms were fully as marked as in the severe streptococcus cases. Even in the severer types of inflammation due to the aureus, they were as a rule of shorter duration than the streptococcus infections.

The cases due to the pneumococcus did not show any special severity.

In the mixed infections the streptococcus and aureus were the most severe. The presence of the pyocyaneus did not exercise any marked influence. The megatherium with the albus produced a rapid and intense inflammation. This case will be reported under mixed infections.

Erysipelas.

Two cases. In each the streptococcus was obtained in pure culture.

Dermatitis.

One case, in which the streptococcus and the albus were found.

Bubo.

Six cases. There were 5 of pure and 1 of mixed infection. Of the pure infections the streptococcus occurred in 1, the aureus in 1, and the albus in 3. In the case of mixed infection the streptococcus and the albus.

Acute Vesiculitis.

One case, in which the gonococcus was found.

Bone.

Two cases of osteomyelitis of tibia and one case of acute periostitis were examined, and the staphylococcus aureus occurred in each case.

Pyosalpinx.

Six cases (tubes removed at operation). The streptococcus occurred in 1, the aureus in 1, the micrococcus lanceolatus in 1, and the gonococcus in 3. The clinical history of these cases is interesting. The 3 due to gonococcus and the 1 due to the micrococcus lanceolatus made good recoveries. The case due to the streptococcus died of septicæmia. The one due to the aureus was accompanied by pelvic abscess and recovery was very slow.

Acute Endometritis.

Three cases. In each of these the streptococcus occurred in pure cultures. Two of these cases occurred after normal delivery and one after an abortion. In each case there were marked septic symptoms and slow recovery.

Peritonitis.

One case. In this case the micrococcus lanceolatus and colon bacillus were found. Patient died in 24 hours after admission, with general fibrinous peritonitis.

Gumma.

One case of gumma of arm. The skin was unbroken. Cultures taken after incision showed the aureus and albus, which were undoubtedly a contamination from the skin. The examination by cover-slip for Lustgarten's bacillus was negative.

Conjunctivitis.

Two cases. In one case the streptococcus and albus were found, and in the other the bacillus diphtheriæ. This latter case was especially severe, threatening destruction of the cornea, and was sent to contagious wards for antitoxin treatment.

Infected Wounds.

In 1 case of wound by bullet from revolver, the streptococcus and albus were found.

Wound from beef bone: 1 case, in which the staphylococcus aureus occurred.

Dog bite: 1 case, in which the albus and an unknown bacillus were found.

Insect bite: 1 case, in which occurred the staphylococcus citerus.

In these cases of infected wounds the bacteria were probably carried in from the skin.

Ulcers.

Thirteen cases of chronic ulcer of the leg were examined. In each case one or more of the pyogenic cocci were found, as might be expected on an exposed surface. These cases are reported, as they bring out several interesting facts.

In 9 the pyocyaneus occurred, and in 4 the bacillus pyogenes fœtidus. The 4 cases in which the fœtidus occurred were all extremely sluggish and stubborn to treatment. Under various dressings they showed no improvement. They were distinctly the worst class of ulcers that came to the Out-Patient Department.

On the other hand, the pyocyaneus did not seem to exercise any deleterious effect on the ulcers. The green pus cleared up after a day or two and usually left the ulcer

clean. There was no increased inflammation, and it seemed that the ulcers were benefited. A clean granulating surface was usually left behind. It is a curious fact that these cases of pyocyaneus infection occurred about the same time. On September 8th a patient came into the Out-Patient Department with furunculosis of the arm in which the pyocyaneus was found. Before this no cases of pyocyaneus ulcers were observed. Two days later 3 of the old chronic ulcers were surrounded by a green rim. The other 6 cases followed in a few days. Evidently the case of furunculosis was the source of this infection. Just how the pyocyaneus was conveyed to the ulcers was not found out.

It was noticed that under dressings of corrosive (wet) gauze the green pus cleared up in a day or two.

Appendicitis.

Fifty cases of appendicitis were examined. In most of these cases there was abscess formation. The cultures were taken from the abscess cavity immediately upon the opening of the abdomen. Where there was no abscess the culture was taken from the stump of appendix. There were 28 cases in which mixed cultures were obtained, 20 in which pure cultures were found, and 2 showed no growth. Of the entire number 12 patients (or 24 per cent.) died.

The streptococcus occurred in 15, the aureus in 1, and the colon bacillus in 46.

Of the 20 cases in which pure cultures were obtained the colon occurred in 19 and the streptococcus in 1. Of the 28 cases in which mixed cultures were obtained, streptococcus and aureus occurred in 1, the streptococcus and colon in 13, and the colon plus a variety of undetermined bacteria in 14.

In case of appendicitis where there is abscess formation, there are usually large numbers of bacteria of various kinds found. These probably come from the intestine, and many of them have no pathological significance.

Of the 12 fatal cases, the cultures taken at the time of operation showed in 7 pure colon, in 3 streptococcus and colon, in 1 colon and undetermined bacteria, and in 1 no growth occurred.

In this latter there was undoubtedly an error in taking the culture, as the case was that of a perforated gangrenous appendix.

Of the 38 cases of recovery, in 12 the colon was found in pure culture, in 1 the streptococcus in pure culture, in 1 the streptococcus and aureus, in 10 the streptococcus and colon, in 13 the colon plus undetermined bacteria, and in 1 no growth.

A study of the clinical records of these cases is interesting. Taking first the 38 cases of recovery, it was found that in the 12 cases from which pure colon was obtained 11 made good recovery, averaging 33 days in the hospital, and 1 was discharged relieved after 10 weeks. Of the 13 cases in which colon plus undetermined bacteria were found, 10 made good recovery, and 3 were slow, 1 of which was operated on a second time.

In this case the streptococcus was found at the second operation. Of the 12 cases in which the streptococcus occurred, 1 in which the streptococcus and aureus were combined made a slow recovery and was accompanied by pelvic abscess, for which a secondary operation was necessary. The one in which the pure culture was obtained was a case which had been operated on 3 months before, and which came in again for a third operation. In this case also the streptococcus was found at the secondary operation, but not in the primary operation. Only colon was found at time of primary operation. Of the remaining 10 cases in which the colon was combined with the streptococcus, in 4 the convalescence was slow, and 2 of these came to secondary operation; 3 made good recovery, and 3 are now in the wards, having been operated on within the past week. The case showing no growth made good recovery, in less than 4 weeks.

In 7 of the 12 fatal cases, pure cultures of the colon bacillus were found. Of these 2 died on the day of operation; 1 within 24 hours, 1 in 48 hours, and 3 in from 5 to 8 days. In all 7 there had been perforation, and in 3 at time of operation there were symptoms of general peritonitis and collapse.

In the case in which the colon bacillus plus undetermined bacteria were found, death occurred from general peritonitis in 2 days. The case from which no growth was obtained had a perforated gangrenous appendix, and death followed on the second day after operation. Of the 3 cases in which the streptococcus occurred, one had made good recovery for two weeks, then suddenly developed secondary abscess and general peritonitis; death two days later. The other 2 streptococcus cases died in 5 and 7 days, with symptoms of general infection. There was only one autopsy. This was on a case in which at time of operation the cultures showed colon bacilli, but no streptococci. The autopsy revealed a general purulent peritonitis, from which both in cover-slip preparations and in the cultures numerous streptococci were found.

The study of these cases brings about this fact, that the absence of the streptococcus from cultures taken at time of operation, where there has been perforation, is of negative value. That it may be an ætiological factor is shown by the 3 cases mentioned above, in which at time of primary operation no streptococci were found, but subsequently they were obtained, once at the autopsy and twice at secondary operations. It is probable that in the presence of the large number of colon and other bacteria usually present in such cases the streptococcus could not grow.

Out of a total of 15 cases of streptococcus there were 3 deaths and 6 slow recoveries, in 4 of which, later, secondary operations were necessary. Three had normal convalescence and 3 were operated on too recently to give full report.

Leaving out the 3 cases now in the wards, we have a death rate of 25 per cent., and 4 out of the 12 cases, or 33 per cent., having secondary abscess formation demanding another operation.

When we consider the cases in which the streptococcus was absent in cultures we find, out of a total of 35 cases, 9 deaths, 5 slow recoveries, and 21 of normal convalescence. In one of the fatal cases the streptococcus was found at autopsy. This case died 8 days after operation. Of the remaining 8 cases 6 died within 3 days, 1 in 5, and 1 in 6

days. The fact that in every one of these 9 cases there had been perforation explains this high death-rate due apparently to the colon bacillus. That the colon bacillus can produce a fatal peritonitis is undoubtedly true, but it is uncommon and only when they are in immense numbers. Welch, in his article "Bacteria of Surgical Infection" (Vol. 1, Dennis System of Surgery), does not regard the colon bacillus in cases of appendicitis as the primary organism. He says, "There is reason to believe that the highly resistant colon bacillus may survive in an inflamed part after the primary organism which started the trouble has died out or has been crowded out by the invader."

This view corresponds with our experience in these cases, and the bacteriological examination of cases of peritonitis which have come to autopsy corroborates it. It is rare to find a case of peritonitis due to the colon alone.

Out of the 8 deaths mentioned above, 6 never rallied after the operation, and in the other 2 there was ample time and opportunity for a streptococcus invasion.

The probability is that in the cases of pure colon the inflammation was started by the streptococcus or some other of the ordinary pyogenic bacteria, and the failure to grow them in cultures was due to the presence of immense numbers of colon.

A careful study of these 50 cases cannot fail to impress us that the occurrence of the streptococcus brings a grave element into the prognosis. Of the cases which came to secondary operation the streptococcus was found in every instance, either at time of first or second operation. In the cases of recovery the streptococcus showed a higher percentage of long-drawn-out convalescence.

The results of the bacteriological investigations of appendicitis are far from being satisfactory. The study of these cases simply emphasizes the fact that the presence of the streptococcus is usually attended with symptoms of the severest type. There is a great variability in the virulence of the streptococci found here as well as in other inflammations. They may cause but slight disturbance, but are far more liable to result in a general peritonitis or septicæmia.

In cases of perforation and abscess formation, it must be borne in mind that the absence from the cultures of the pyogenic cocci is of negative value.

Otitis Media.

Thirty cases, 24 pure infections, and 6 mixed infections. The streptococcus occurred in 14: 12 times in pure culture, and twice with aureus. The micrococcus lanceolatus 5 times, in pure culture. The capsule bacillus occurred in 2: once in pure culture and once with the diphtheria bacillus. The aureus occurred 5 times: twice in pure culture, twice with the streptococcus, and once with the diphtheria bacillus. The albus in 4: twice in pure culture, once with the diphtheria bacillus, and once with an unknown bacillus.

The Klebs-Loeffler bacillus (bacillus diphtheriæ) occurred 4 times: once in pure culture, once with the capsule bacillus, and once each with the aureus and albus. A large spore-bearing bacillus, closely resembling the anthrax bacillus in its growth and size, was found in two cases: once in pure culture from the mastoid cells and once from middle ear with the albus. This bacillus was not pathogenic for guinea pigs or rabbits. The writer was unable to identify it.

Of these 30 cases of acute ear 14 developed a severe mastoiditis which necessitated operation. Cultures were taken from these latter from the mastoid cells as well as from the middle ear. In these mastoid cases the streptococcus occurred in 10: 8 times in pure culture and twice with the aureus. The micrococcus lanceolatus occurred in 2, in pure culture: the diphtheria bacillus with capsule bacillus in one, and the large spore-bearing bacillus in one.

There were 5 deaths in the 30 cases. In these cases the streptococcus occurred in 1, the pneumococcus (micrococcus lanceolatus) in 1, the aureus in 1, and the capsule bacillus in 2, once pure and once combined with the diphtheria bacillus.

The capsule bacillus found in these cases resembled that of Friedlander, but differed from the Friedlander bacillus in that it always grew with capsule surrounding it, when cultivated on artificial media. There were also several

minor points of difference. It apparently was identical with the capsule bacillus described by Mallory and Wright.[1]

Of the fatal cases, in the one due to the streptococcus the patient died with symptoms of general infection within five days. In the case due to the aureus, a brain abscess followed, death resulting in three weeks after ear trouble began.

In these two cases the middle ear was the primary focus of the fatal infections. In the other three cases the ear trouble was secondary and death was due to other causes. In the two cases in which the capsule bacillus was found, one in which the diphtheria bacillus was found, the patient died of pneumonia and general infection with the micrococcus lanceolatus. At the autopsy the micrococcus lanceolatus was found in the lung, heart's blood, and kidney, but not in the middle ear. The capsule bacillus and the diphtheria bacillus were found in the middle ear, but nowhere else. There was no extension of ear trouble to the cranial cavity. In the other case of capsule bacillus death was due to fracture of the base of the skull. In the case of the micrococcus lanceolatus there was pneumonia and general infection. The ear trouble began during the course of the pneumonia. Of the 25 cases which recovered the streptococcus occurred in 13, the aureus in 4, the albus in 4, the micrococcus lanceolatus in 4, the bacillus diphtheriæ in 3, and a large unknown bacillus in 1.

The cases in which the streptococcus occurred were, as a rule, the worst. This is illustrated by the fact that in the 14 streptococcus cases 1 died and 10 came to operation for mastoiditis, while only 3 made recovery without any severe symptoms.

Of the 5 cases in which the aureus was found, 2 recovered in 1 week. One in which the streptococcus was also found recovered in 6 weeks; 1 accompanied by the streptococcus also recovered in 3 weeks; and 1 died with brain abscess.

Of the 5 cases in which the micrococcus lanceolatus was found, 1 died (death due to pneumonia and general infec-

[1] Centralblatt f. Bacteriologie, 1895.

tion), 2 came to operation for mastoiditis, and 2 made recovery in 1 and 2 weeks respectively. The 2 cases which came to operation recovered, one after 5 weeks and one after 2 weeks. The cases in which the diphtheria bacillus was found did not show any special symptoms, except the one in which the pure culture was found. This patient had been in the diphtheria wards, from which he had been discharged some time before his ear trouble began. It was several weeks after his discharge that he presented himself at the Out-Patient Department with an acute ear. Bacteriological examination showed a pure culture of the diphtheria bacillus from the discharge from ear. Patient recovered without any unusual symptoms being observed.

Of the 2 cases in which the large unknown bacillus was found, the one which came to mastoid operation was discharged well in 6 weeks, the other in 2 weeks. The latter was accompanied by the albus; the culture was taken from the middle ear.

It is a question whether this large bacillus had anything to do with the process. The cases in which the albus was found were all of a mild nature. It is probable that in several, at least, of these, the presence of the albus was due to contamination of swab from external ear.

Six of the 30 cases occurred during the course of acute diseases: 3 in the course of typhoid, and 3 in the course of pneumonia.

Of the 3 cases occurring during typhoid, 2 were in the third week and 1 in the second week of the disease. In the first 2 the streptococcus was found, and in the latter the micrococcus lanceolatus. Of the 3 cases occurring during pneumonia, in 1 the aureus and diphtheria bacillus was found on the third day of the disease. In the second case the micrococcus lanceolatus was found on the seventh day.

In the third case the capsule bacillus and bacillus diphtheria were found at the post-mortem examination. Patient complained of his ear just before death.

The conclusion to be drawn from a study of these cases is that the pyogenic cocci, especially the streptococcus, produce the severest forms of inflammation of the middle ear. While the pneumococcus may produce very severe inflam-

mations and involve the brain or its coverings, still in the absence of pneumonia or other complications the cases tend to recover readily.

Empyæma.

Eighteen cases. Of these 16 were caused by a single organism and in 2 mixed cultures were obtained. The streptococcus occurred 8 times, the pneumococcus 9 times, the staphylococcus aureus once. In the cases where mixed cultures were obtained, in one, in which there was an accompanying pneumothorax, the streptococcus and a variety of undetermined bacteria were found. In the other case the culture was taken some time after operation, and the pyocyaneus, the pneumococcus, and a number of other organisms were found.

Taking the 16 cases in which pure cultures were found, 8 were due to the pneumococcus, 7 to the streptococcus, and 1 to the staphylococcus aureus.

In the 8 pneumococcus cases there was one death. This patient also had heart disease. Of the recoveries one combined with unresolved pneumonia was slow, extending over some months. The other 6 patients made good recovery.

The case due to the staphylococcus aureus was very slow, with marked constitutional disturbance. In the study of these cases we are impressed with the uniformly favorable course and termination of the cases due to the pneumococcus in the absence of complications. On the other hand, those due to the streptococcus have been as uniformly severe, with the high death-rate of 43 per cent.

Mixed Infections.

Of the cases of mixed infection deserving special mention those of the fœtidus and pyocyaneus in connection with chronic ulcers of the leg have been spoken of under ulcers. There are two others of interest.

The first is the case of cellulitis due to the staphylococcus albus and megatherium bacillus.

The history of the case: Patient a man about 50 years, in the employ of the health department of the city of Boston. His work consisted in collecting garbage. Came

into the Out-Patient Department September, 1895, giving the following history: Scratched the back of his hand in some manner the day before. The scratch was not deep and not particularly painful and did not bother him any, and for the time he forgot all about it. That night noticed his hand was considerably swollen. This grew rapidly worse. Hand and forearm swelled considerably during the night and became very painful, so he could not sleep. Examination showed right hand and forearm very much swollen; back of hand red and tender; patient, though a strong man, looked very shaky. The hand was freely opened by Dr. Dwight; there was no pus. Cultures were taken from swollen œdematous subcutaneous tissue. A wet corrosive dressing covering the hand and wrist applied. Patient advised to go into the hospital, but went home. Cultures showed staphylococcus albus and an unknown bacillus, which after cultivating on various media was identified as the megatherium. These cultures gave off a peculiar characteristic odor, that of stale swill. This bacillus was first discovered by DeBarry on the leaves of boiled cabbage. It is non-pathogenic. This sudden intense inflammation coming on a few hours after inoculation could hardly be due to the albus alone, which usually takes several days to produce any marked inflammation, and usually with the albus the process is mild. It is probable that the megatherium, though by itself non-pathogenic, played an important part in this case by markedly increasing the virulence of the albus.

The second case was that of the anthrax and staphylococcus citreus, in a case of malignant pustule of the neck. This case, a young man, a longshoreman by trade, came into the hospital in the service of Dr. H. L. Burrell, in February, 1896. The man at time of entrance had a temperature of 105 degrees. Before the operation bacteriological examination of the fluid contained in the vesicles surrounding the eschar showed many of the characteristic anthrax bacilli. Cultures were made from the vesicles, from the subcutaneous tissue after removal of tumor, and from the tumor itself. From the vesicles and just under skin mixed growths of anthrax and citreus were obtained. From the

depth of the wound after removal of tumor a pure culture of the citreus; no anthrax.

The first thing that struck the writer upon examining the cultures after 18 hours' growth was that in all three there was apparently macroscopically a pure growth of the citreus. It was only on close inspection that a slight whitish ill-defined growth at bottom of tube was observed in two of the tubes. Microscopical examination showed this whitish growth to be anthrax. The staphylococci far outgrew the anthrax. The anthrax and citreus were finally obtained in pure cultures from the original mixed culture. It occurred to the writer upon observing that the citreus grew so profusely with mixed cultures, while the anthrax showed but slight growth, that there might be some antagonism between them. A series of experimental inoculations was conducted on guinea-pigs, with the following results:

The cultures used were second and third generations obtained in pure cultures from original by transplantations on Loeffler's blood serum. The guinea-pigs were all about same size, varying slightly from 400 grmms. 1st. One pig inoculated with ½ cc. of a 24-hour bouillon culture pure anthrax; died in less than 48 hours. At autopsy, pure cultures of anthrax recovered from heart's blood and spleen. 2d. Two pigs inoculated, on same day as the first, each with ½ cc. of a 24-hour bouillon culture of anthrax and ½ cc. of a 24-hour bouillon culture of the staphylococcus citreus; were alive and well after 2 weeks, and were subsequently used for other inoculations. 3d. One pig inoculated with 1 cc. of 24-hour bouillon culture of the pure citreus failed to produce any marked effect. Animal was kept under observation for a month, and after the first day or two was as lively as ever. The inoculations were all made in the abdominal subcutaneous tissues.

The writer was unable to find any evidence that this action of the staphylococcus citreus was observed before. Other observers have shown that the streptococcus and the staphylococcus aureus possess the same power of antagonizing the anthrax bacillus. Emmerich (Emmerich, R., "Die Heilung des Milzbrandes durch Erysipelserum," Munch.

Med. Wchnschr., 1894, Nos. 28–31) in 1886, experimenting on rabbits, found that the streptococcus, injected subcutaneously or into the vein, would arrest the growth of anthrax. He first inoculated the animal with pure anthrax, then followed it with a subcutaneous or intravenous injection of the streptococcus. Other observers have reported a similar action by the staphylococcus aureus and by the capsule bacillus of Friedlander.

Post-Mortem Infections.

It is interesting to note the experience of pathological staff with infections from post-mortem work. The only infections worthy of mention have occurred either by hangnails or by means of hair follicles. By far the greater number occurred through hair follicles. Cuts received by the autopsy knife healed readily. The usual treatment was: allow the wound to bleed freely, wash with corrosive, and dress with corrosive pad. The usual places of hair follicles infection are back of hand and ulnar side of wrist or lower forearm on its posterior aspect. The organisms are massaged into the hair follicles by the friction attending the removal of the various organs, and often by the habit of the operator resting his wrist upon the edges of the open thoracic or abdominal cavities.

In connection with these infections it is also interesting to note that different individuals are more susceptible to certain bacteria than others. For example, in one man connected with the Pathological Department the infections are always with the aureus, while the streptococcus is the infecting organism in another. The writer's experience in four post-mortem infections has been in each case with the aureus.

CONCLUSION.

The writer is indebted to Dr. Thomas B. Cooley, house physician, for valuable assistance in the work on the Out-Patient Department cases, and to Dr. Charles S. Wright, aural house physician, for assistance in taking cultures and preparing report of aural cases.

IV.

ON AN UNUSUAL PATHOGENIC ACTION OF THE DIPHTHERIA BACILLI.

By Dr. T. Leary,
First Assistant in the Pathological Laboratory, Boston City Hospital.

The first complete description of the pathogenesis of the diphtheria bacilli was given in the work of Roux and Yersin. In this work the toxin produced by the bacilli was described and the lesions in internal organs ascribed to its action. They only found the bacilli in the pseudo-membrane. Loeffler also never met the bacilli in the internal organs, but only in the membrane, and says they never enter into the blood-vessels and internal organs.

The first description of the presence of the bacilli in the internal organs was given by Babes, who found them in three cases. This was followed by the more extensive work of Frosch, who found them in the brain, lungs, liver, spleen, kidneys, lymph glands, as well as in the blood of the heart. Other observations on the same subject have followed those of Babes and Frosch. In the series of examinations of autopsies both in human and experimental diphtheria, Wright has shown their very common appearance in the internal organs. The bacilli are found by using for the culture a comparatively large amount of the organ to be investigated. They have not been found in microscopic sections of the organs, nor can the focal necrosis in the liver, lymph glands, and other places be shown to have any connection with the bacilli. It has, in consequence, been generally assumed that the conclusions of Roux are correct; that the bacilli only find suitable conditions for growth in the pseudo-membrane on the mucous surface; they grow there and produce toxic substances which are absorbed, and to which the in-

ternal lesions and the death of the individual are due; the bacilli which are found in the internal organs by culture are due to the accidental entry of organisms which find their way into the blood as inert particles of carbon might, and which do not increase nor produce lesions in the tissues. The bacilli are found most frequently in the lungs, in connection with foci of broncho-pneumonia, which are almost constantly found in diphtheria autopsies. Howard found bacilli, which in all points of morphology and culture agreed with the diphtheria bacilli, in a case of acute endocarditis and nephritis. These bacilli were shown on microscopic examination to be present in the lesions, and in such relation that the lesions must be supposed to be due to the bacilli. The bacilli which Howard described were not pathogenic for guinea-pigs. Kutscher has recently made a careful histological examination of the lungs of children who have died of diphtheria, and has found the bacilli in the foci of broncho-pneumonia. The bacilli were found both free and enclosed in cells in the alveoli, and in the lymphatics around the vessels. They were present in the earliest lesions and could be referred to their presence. He supposes that they can enter the tissue either by the bronchi or by the blood. In the seventh series of the City Hospital Reports, Councilman and Mallory have published two cases of tuberculosis in which the lesions were purely inflammatory and resemble most closely lesions produced by one of the purely pus organisms. The following two cases show that the diphtheria bacillus may under certain circumstances exert a similar action:

Case I. — Pustule on finger appearing three days after autopsy on a case of diphtheria. Diphtheria bacilli found in pus and in culture from this. Death of guinea-pig inoculated.

On January 27 the writer made an autopsy on a child which had died of diphtheria. The case was a severe one of the septic type. Diphtheria bacilli were found in cultures made from the mouth during life, and in the cultures from the lungs, bronchi, larynx, and tonsil made at the autopsy. No inoculations were made from these cultures.

Three days after the autopsy a small, slightly elevated red point, surrounded by a hyperæmic area, appeared on the posterior surface of the base of the middle finger of the left hand. The swelling was not especially painful; it increased somewhat in size, and three days after its appearance it became converted into a pustule about 2 mm. in diameter. There was nothing in its appearance or manner of development to distinguish it from the common anatomical pustule due to infection with the pus organisms. The pustule was opened, and thick creamy pus removed. Microscopically it consisted of polynuclear pus cells. Considerable numbers of diphtheria bacilli were found both free and enclosed in cells. Cultures were made, and after 24 hours showed an abundant pure growth of diphtheria bacilli. A guinea-pig was inoculated with the pure culture and died in 30 hours with the lesions of experimental diphtheria. The pustule of the finger was disinfected with corrosive, and a drop of pure carbolic acid placed in it. After recovery from the surgical procedure it healed readily.

In this case there can be no doubt as to the nature of the process and the ætiological connection of the bacilli. Cutaneous lesions, in which diphtheria bacilli are found, are frequently met with in autopsies on diphtheria. The lesions which are inflicted and infected by the patient consist in slight excoriations due to scratching. They are covered by a scab, and beneath this in the shallow ulceration the bacilli may be found pure or mixed with pus organisms. Definite pustule formation due to the bacilli has never been found in these cases, and we have never found it described in the abundant literature of the disease.

Case II. — Typhoid fever with parotiditis, gangrenous stomatitis, thrombus in the external jugular. Diphtheria bacilli found in the cultures from the lungs and by microscopical examination in the thrombosed vein and in the foci of pneumonia.

The patient entered the hospital eleven days before death. He gave the usual history of typhoid fever. A week before death a diffuse swelling of parotid and of the tissues about the lower jaw developed, which did not come to abscess for-

mation. At the autopsy the alveolar process of the lower jaw on the left side was denuded of periosteum, the tissues about it gangrenous and sloughing. There was some inflammation extending to the parotid and the submaxillary gland on the same side. In the external jugular vein there was a soft, partially broken down thrombus. In the lungs there were numerous foci of embolic pneumonia and abscess formation beneath the pleura, bronchitis, and broncho-pneumonia. The spleen was swollen. The intestine showed typhoid ulcers in the stage of beginning to heal.

No typhoid bacilli were obtained from the cultures. The lungs gave an abundant growth, in which the diphtheria bacilli predominated. There were a few colonies of staphylococcus aureus in addition. The cultures were made from the abscesses beneath the pleura. The diphtheria bacilli were large, and appeared degenerated. They did not grow on blood serum tubes which were inoculated from the first to obtain pure cultures. A guinea-pig was inoculated with the impure culture, and in two days considerable œdema and induration developed around the seat of inoculation. This was opened, and cultures made from the contents. These gave a pure and typical culture of diphtheria bacilli. The guinea-pig recovered. Inoculations were made from the second pure cultures with negative results.

Microscopic examination of the submaxillary gland showed a diffuse purulent infiltration. Adjoining the gland in the inflamed tissue a small vein was thrombosed, the thrombus containing the same bacilli as the thrombus in the external jugular. No microscopic examination was made of the gangrenous tissue about the lower jaw, as diphtheria was not suspected. Sections of the external jugular showed a thrombus formed principally of white and red corpuscles, and a small amount of fibrin. In the thrombus there were large numbers of bacilli morphologically identical with the diphtheria bacilli. They were arranged in large masses and in small clumps, just as they are found in the pseudo-membrane. In the sections of lungs masses of them were found in the abscesses, in the pus, and tissue detritis. Thrombi composed of bacilli without any lesion of the surrounding lung were found. The abscesses had developed around

such thrombi, and in one place the wall of the thrombosed vessel was necrotic, the bacilli had grown through the wall, a mass of them outside the vessel being in continuity with those inside. There was bronchitis and broncho-pneumonia, in which pneumococci were found. These were absent from the cultures that were made from the embolic foci. Most of the bacilli found in the lung were in masses; only a few scattered ones were found in the alveoli, and these were not enclosed in cells.

It is to be regretted that cultures were not made from the external jugular vein. This was not done because the tissue was saved for microscopical examination, and it was supposed that the same sort of organisms would be found in the lungs. There can be but little doubt that the infection started from the mouth. An infected thrombus was produced in one of the small veins of the submaxillary glands, and from this extended into the external jugular. The lung abscesses were due to emboli from the softened thrombus. The bacilli agreed in all respects, both morphologically and in cultures, with the diphtheria bacilli, but were not virulent for guinea-pigs. A lack of virulence towards guinea-pigs is not uncommonly seen in diphtheria bacilli obtained from typical and virulent cases of diphtheria. While it must be admitted that the general action of the diphtheria bacilli is typically local and their essential action is in the production of toxines, these two cases show that they can in some cases exert a typical pyogenic action. The same thing is true of the tubercle bacilli. In one of the two cases of Councilman and Mallory which were referred to above, the lesions in the lungs were macroscopically and microscopically so typically suppurative that, without the proof of the presence of the bacilli, they would certainly not have been considered tuberculous. It is probable that the cause of the abnormal action of the diphtheria bacilli should be sought in some variation in the organism, and not in the character of the tissues. There have been four other cases of mixed infection of typhoid fever and diphtheria found at autopsy in the last four years at the City Hospital, and in all of these the diphtheria lesions were typical and apparently not influenced by the typhoid process.

V.

A STUDY OF THE ADAPTATION OF THE X-RAYS TO MEDICAL PRACTICE AND SOME OF THEIR USES.

By Francis H. Williams, M.D.

In the winter of 1896, not long after the announcement in America of Professor Roentgen's discovery of the X-rays, I was impressed with their possibilities for usefulness in the practice of medicine, and as soon as I had gained some familiarity with the physics of the subject I began to examine my patients by their means, and have done so constantly ever since. The number I have thus far examined amounts now to more than two hundred and fifty, and the more extended my experience has become in making these examinations, the more valuable have I found the rays in diagnosis in suitable cases.

During the progress of this study I have from time to time reported my results at medical meetings [1] or by published articles,[2] but only in outline, and I shall now endeavor to present more fully, at least a part of my work at the Boston City Hospital. The use of the X-rays in medicine was so new that apparatus and methods had to be devised before patients could be examined satisfactorily, and as members of the profession from various parts of the country have been interested in seeing my methods, it will perhaps be useful to describe for others some of the apparatus used, before taking up the medical side of the subject.

Of the various forms of apparatus employed to excite the Crookes tube I have found the static machines, although

[1] Meeting of the Suffolk District Medical Society, April, 1896.

Meeting of the American Association of Physicians, April 30, 1896.

Meetings of the Boston Society for Medical Improvement, and of Medical Society of the Boston City Hospital, October and November, 1896.

[2] "Proceedings of the American Association of Physicians," 1896. "Boston Medical and Surgical Journal," Oct. 1, 1896.

at a disadvantage in moist air, the most satisfactory, and of these prefer that known as the Wimshurst. The one I have principally used was designed by Mr. C. L. Norton and Mr. R. R. Lawrence, of the Massachusetts Institute of Technology (see Fig. 1), and has twelve glass plates, 26 inches in diameter, which are run at about 200 revolutions per minute, and is boxed in order to keep out the dampness. I have ordinarily used it without condensers in making examinations with the fluorescope, but in taking radiographs

FIG. 1.—Static machine and stretcher, with tube holder below; large fluorescope at left of picture. This cut shows method of examining a patient.

condensers are an advantage. It may be of interest to state here that I found the surface of the glass plates was less susceptible to dampness when a few drops of castor-oil were added to the thin shellac with which they were coated. Vulcanite plates may be used instead of glass plates, but they do not seem to be as good electrically, although, of course, they are less likely to be broken; still, with ordinary care, there is not much danger to glass plates while handling the machine, and those of 26 inches in diameter I have run, in order to test them, at 900 revolutions a minute without breaking them, even though not carefully centred,

while those of a smaller size, if carefully balanced, may be run at a much higher speed. Attachments to the Crookes tube for lowering the vacuum are not necessary when using this machine, as the vacuum is only slowly raised.

The Crookes tube does not seem to require a large amount of electricity for its successful use. The prevention of leakage — and this leakage is very great in moist air — is the practical difficulty to be overcome. To this end, all parts of the machine should be carefully insulated, and leakage from the conducting wires and connections reduced as much as possible. The tube should be exhausted to the degree of pressure suitable to the apparatus used, a large static machine requiring a tube with a high degree of exhaustion. The resistance of the tube increases after it has been used for some hours, but this resistance may be reduced by heating the tube over a flame while turning it in the hand. This does not require to be done often. There are certain limits in the vacuum between which the X-rays are given off: if the vacuum is too low there are no rays; if too high the resistance of the tube is so great that it cannot be overcome and no fluorescence is produced on the screen. The best results seem to be attained when the vacuum is as high as the tube can be made to work successfully. The following suggestions from the experience of Mr. G. A. Frei are sometimes serviceable: If the vacuum is a little too low it may be made higher by running the tube with a closed spark-gap; if too high it may be lowered by running the tube with a closed spark-gap and with the current reversed. If there is not time to lower it in this manner the difficulty may sometimes be overcome for the moment by grounding the anode.

To do the best work, good Crookes tubes are necessary, and an abundant supply of suitable electricity, more or less of which can be used as the conditions of the moment require.

Next in importance to a good machine for exciting the X-rays and a good Crookes tube comes the fluorescope. Fluorescopes with screens made of tungstate of calcium have generally one great disadvantage; namely, the screen remains bright, and the image of the object persists sometimes for

several minutes after the fluorescope is taken away from the tube; but from the tungstate of calcium screen, which is the result of the patient and laborious investigation of Mr. T. B. Kinraide, of Jamaica Plain, Boston, Mass., the image disappears as soon as the fluorescope is removed from the tube. I use three sizes: one 3 by 4 inches, one 7 by 9 inches, and the third 11 by 14 inches.

Being now supplied with satisfactory apparatus, how can we use it to obtain the best results, and at the same time render the patient most comfortable during the examination?

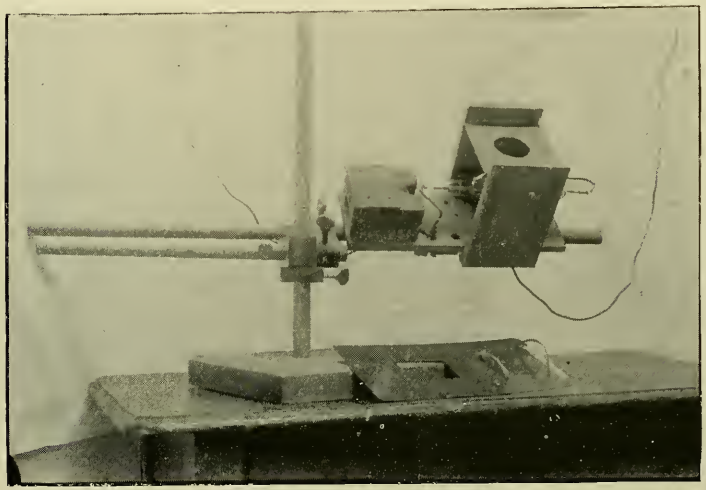

FIG. 2. — Holder for Crookes tube; metal plate with rectangular opening lying on base of holder.

The room in which the examination takes place should be darkened, and, for further facilitating the end we have in view, I have devised the following appliances: First, the use of a canvas stretcher (see Fig. 1), which is placed when needed on supports connected with the table on which the static machine stands, and which may be drawn out or pushed in at pleasure. The patient rests easily on this stretcher, and may turn from side to side if required, and all portions of the body can thus be readily examined.

Second, an adjustable stand for holding the Crookes tube (see Fig. 2), the arm of which may be raised or lowered, shortened or lengthened, as desired. This may be placed

under the stretcher, and as the X-rays penetrate the canvas as easily as they do the clothing, the patient is, as it were, suspended in the air over the tube, and all portions of the body are accessible. While examining the patient through the fluorescope held in one hand, the other is free to change the intensity of the light, which is readily done by varying slightly the length of the spark-gap. It is important to have sufficient light, but it is equally important not to have too much light. It is also sometimes advantageous during an examination with the fluorescope to move the Crookes tube from side to side, and by thus changing the position of the shadow of the part or foreign body more is learned than by one view.

Third, a device which enables us to overcome the difficulty which we sometimes encounter, of getting a sharp definition and excluding unnecessary rays even when using the best fluorescope. This appliance consists of a piece of sheet metal (*e.g.*, brass) six inches wide by twelve inches long, and thick enough to prevent the passage of the X-rays, toward one end of which is cut a rectangular opening — this is preferable to a circular one — about two by three inches being a convenient size. After taking a general survey with the fluorescope, the part of the body that is to be carefully examined is selected, and the metal plate held close under the stretcher in such a position that the X-rays coming from the Crookes tube fall directly through the opening, while the surrounding area is shielded by the metal. The fingers should be protected from the rays while holding the plate, and to accomplish this object leather straps are fastened on to the plate, so that the fingers may be inserted under them on the upper side; the plate may be moved about and any special part examined. A diaphragm may be used near the Crookes tube, instead of the plate, made of sheet metal with a circular opening from about one to two inches in diameter, which may be slid into the grooves of the wooden pieces on each side of the tube. When in a groove near the tube the cone of rays is broad, when farther away it is narrower.

Fourth, a pencil for tracing the outlines of a given organ or object during the examination of the patient with the fluorescope. This pencil is made of metal, with a crayon

point suitable for marking the skin, and along one side is a strip of lead wire which is held in place by means of sticking-plaster wound around the pencil. Were it not for this lead the X-rays would pass through the crayon so that it would not be visible, but by its means a dark shadow is cast, and one can see, as it were, the end of the crayon.

The radiograph and fluorescope are both useful in practice. In taking the former it is most convenient to place the Crookes tube above the portion of the body of which a picture is desired, and the best direction of the part with regard to the tube in other respects may be frequently learned by previously examining the patient with the fluorescope. The nearer the part to the photographic plate, and the greater the distance of the tube, the sharper the picture. As in practice it is requisite to spare the time of the practitioner as much as possible, photographic plates wrapped in dark paper and enclosed in envelopes to protect them from the light are convenient, because, after being exposed, they may be sent, without opening the envelope, to the photographer to be developed. If it is desirable to have a picture within a few minutes, bromide paper enclosed in dark envelopes may be used, and developed directly. This is, I believe, the readiest way of obtaining a permanent record by means of the X-rays. If other copies are desired, the bromide paper may be coated with oil or paraffine, and prints may be made from it as from a glass negative. If two or three pieces of bromide paper are placed in the same envelope with a glass photographic plate, which, as already stated, is first wrapped in dark paper, the advantages of both methods are combined. A fluorescent screen is sometimes placed against the photographic plate in order to shorten the time of exposure. The objection to this method is that the radiographs are somewhat mottled and the picture loses in clearness. The following method is useful and satisfactory in taking radiographs. The sensitive side of a sheet of bromide paper is placed upon a thick screen of tungstate of calcium made of uniformly fine crystals and with a perfectly smooth surface. The rays pass readily through the paper, act first upon its coating, and

then cause the tungstate of calcium to fluoresce. This fluorescent light also acts photographically upon the bromide paper, and the total effect of the action of the rays is very much increased.

The radiograph gives the permanent record, and makes finer distinctions possible, but, in the nature of things, affords only one view of a given organ or bone; whereas the fluorescope enables us in a moment to see these from different points of view, and we can thus get a better idea of the conditions present in a short space of time. The fluorescope is likewise peculiarly applicable to moving organs, such as the heart and lungs.

An examination with the fluorescope may give an erroneous idea of the size and position of a given organ unless the relation of the position of the Crookes tube to the body is understood. By position I include distance and direction. This must also be borne in mind when taking a radiograph. In an examination of the heart, for instance, when the Crookes tube is about six inches behind the back of the patient and the screen of the fluorescope is directly over the chest, it is obvious that the shadow of the heart will be much larger than the heart itself. To gain an exact knowledge of the size of the heart the Crookes tube should be two feet or more from the screen of the fluorescope, which should be held close to the body.

Let me describe the method pursued in one of the simplest practical uses of the X-rays; namely, that of locating a bullet, whether in the head, body, or extremities. If unable to walk, the patient is brought in on a stretcher, which is placed directly on the supports attached to the static machine table (all the hospital stretchers are of the same size and fit the grooves in the supports), and the Crookes tube is placed underneath. If the physician has just come into the dark room from bright daylight, he must wait until his eyes accustom themselves to the darkness; the machine is then started, and the spark-gap adjusted to the length most suitable to the condition of the tube, this length being determined by examining the patient through the fluorescope.

Everything being now in readiness, the fluorescope is

placed directly on the thigh (let us suppose the bullet is there), and the examination is begun. After looking a moment the spark-gap may be changed a little in order to increase or diminish the light, as by means of this variation more can be seen, certain things showing better in a bright light and others in a less brilliant one. With a bullet it is generally well to use a considerable amount of light. After the fluorescope has been moved about a little, the shadow of the bullet is found, and the spark-gap may again be changed in order to get as clear a shadow as possible. The physician, while still looking through the fluorescope, then makes with the pencil already described a mark over the place where the bullet seems to be, and directly under the fluorescope; he then makes a corresponding mark on the side of the thigh nearest the Crookes tube, over the shadow of the bullet, and draws 1 and 1 by the side of each of these two marks. Then, while still looking through the fluorescope, the Crookes tube should be moved horizontally a few inches to and fro in order to learn how deeply the bullet is imbedded, for if the shadow of the bullet moves considerably in the fluorescope the bullet is some distance away. If it moves very little it must be near the fluorescope and the surface of the skin. If far from the surface its shadow will, of course, be ill-defined; if near, it will be very sharply defined. Next, the patient should be turned so as to allow the physician to look through the thigh in a direction about at right angles to that first taken, and, as before, a mark should be made with the pencil over the place where the bullet seems to be, both when the point of the pencil is held directly under the fluorescope and on the side of the thigh nearest the Crookes tube. These points should be marked 2 and 2, and the bullet will be found at the point where the line drawn from 1 to 1 intersects that drawn from 2 to 2. I have used this method for locating bullets in different parts of the extremities, and in the neck, thorax, back, and abdomen, and usually the situation of the bullet is readily determined by this means. The first bullet I located in this way was in April, 1896.

Let us now consider the principles upon which the use of the X-rays depends. These rays are probably, so far as our

present knowledge goes, ether waves, but shorter than the waves of light, perhaps $\frac{1}{10}$ to $\frac{1}{15}$ as long. Two properties of these rays interest us especially, and upon them depends their usefulness in medicine: First, their power of exciting fluorescence in certain substances. When the X-rays strike tungstate of calcium in a dark room it is seen to fluoresce, and the greater the number of rays which come into contact with it the greater the fluorescence. Second, the difference in their ability to penetrate different substances. It is more difficult for these rays to penetrate bone than muscle, for instance; hence more are intercepted in their passage through the former than the latter, with the result that a darker band is seen upon the bright screen in the one case than in the other. The picture we get in the fluorescope and the impression made upon the photographic plate depend, then, upon the greater or less resistance which the various parts of the body offer to the Roentgen rays. Let us therefore consider briefly the principal causes of this difference in permeability. First, bulk: a thin layer of a given substance will be more readily penetrated by the rays than a thicker one; second, chemical composition. The first needs no comment; but the second deserves attention, as a clear appreciation of the possibilities and limitations of the X-rays in distinguishing between healthy and diseased parts is based largely upon a knowledge of the chemical composition of these parts. This knowledge leads us to avoid mistakes and disappointments on the clinical side which would not be experienced did physicians and surgeons appreciate the relation of the X-rays to chemical composition, and points out certain ways in which these rays are capable of rendering aid.

The following experiment with calculi illustrates in a striking manner how important to us is a knowledge of the chemical composition in our use of the Roentgen rays in medicine. Before attempting to detect any form of calculi in the body, I first placed several different kinds over a photographic plate, which was enclosed in dark paper to shield it from the light, and exposed them for a few minutes to the X-rays. The rays penetrated the calculi made up of uric acid, of cholesterine and biliary salts, very readily, but were

obstructed by calculi containing oxalate of calcium in considerable proportion, phosphate of calcium, or other inorganic constituents. Further study showed that organic substances are quite as readily penetrated by the X-rays as the soft tissues of the body, and therefore it is obvious that any attempt to detect in the body calculi made up of organic compounds would, so far as our knowledge now goes, be futile, whereas those of inorganic origin might be detected.

If diagnosis by some other means than the X-rays shows that there is a calculus in the bladder, for instance, which cannot be demonstrated by a good radiograph taken by

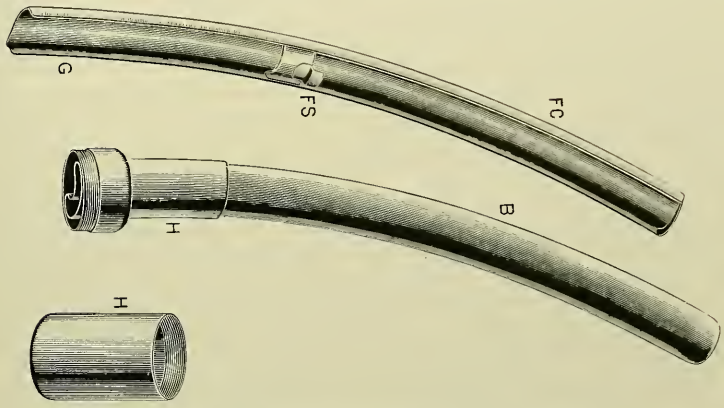

FIG. 3. — Instrument for radiographing a calculus in bladder.

means of an instrument described below, we know it is made up of uric acid or some substance composed chiefly of organic constituents. Calculi may occur made up of substances some of which are, and some of which are not, permeable by the X-rays. The instrument just referred to was devised by Dr. William H. Rollins, of Boston, and consists of an aluminum tube 9 inches long and 1 inch wide, a cross section of which bears some resemblance to a crescent, one-half of its outline being in a general way parallel to the other half. The tube is closed with a solid piece of metal at one end, and to the other is fitted a handle which screws on (see H and H, Fig. 3). FC is a thin piece of metal with grooved edges which holds several pieces of photographic film or pieces of bromide paper which should be about as wide as the tube

and about half as long. To put the films in place the sliding piece FS is removed from FC, the films slid into the grooves and pushed to the end as far as they can go, after which the piece FS is put back to hold the films in place. The whole is then pushed inside of HB and the round handle H screwed on; this must be done in a dark room. The instrument carrying the films, with the convex side up, is then inserted into the rectum of the patient, who is placed on his back, and the instrument is held in such a position that the films are brought just below the bladder. The rays from the Crookes tube, which is placed over the bladder and some inches from the abdominal wall, penetrate the tissues and the aluminum wall of the tube and act upon the film. After an exposure of a few minutes the instrument is withdrawn and the films taken out in a dark room and developed like any photographic plate. In the two cases in which I have used this instrument nothing was found on the films; the calculi were removed and proved on analysis to be made up of uric acid.

Fig. 4 is taken from a radiograph of the various calculi already referred to, which were lent to me by Dr. William F. Whitney, from the Harvard Medical School, and at his suggestion I added to the plate a dry bone, an incinerated bone, and a decalcified bone. The removal of the organic matter from the incinerated bone made little difference in the penetration of the rays, whereas the removal of inorganic matter (mineral salts) in the decalcified bone allowed the rays to pass readily.

In order to gain some conception of the susceptibility of the various constituents of the body to the X-rays, I made several radiographs of a considerable variety of substances, and one of them I have had reproduced here. The conditions of this experiment, the result of which is shown in Fig. 5, were as follows: Equal bulks of substances which represented in a general way the chemical constituents of the body were placed in small pasteboard boxes of the same size, namely, 15mm. in depth, 38mm. in length, and 25mm. in width, those containing liquids being first coated inside with shellac, and the weights and contents being noted on each box. The boxes were then placed on a photographic

ERRATUM.

Page 144, 12th line from top of page, for "inches" read "distance."

plate enclosed in dark paper, and exposed for about two minutes to the action of the rays at a distance of two feet.

FIG. 4. — The two upper rows of objects in this radiograph are calculi. The two calculi on the left are composed of uric acid and urates; those on the right of phosphates; and the two in the middle of oxalate of calcium and uric acid, the upper one of these last two having an outside coating of urates. In the centre of the picture is a round aluminum cup, containing water, one inch in depth, and on either side of this cup is a group of gall stones, and to the right and below the cup a single large gall stone is seen indistinctly. In the left-hand lower corner is a decalcified bone, bent into the shape of ∩, with a lead tag attached by a copper wire. The decalcified bone surrounds an incinerated bone, which is lying on a piece of cotton wool in a wooden box with a glass side. In the right-hand lower corner is a dry bone; in the extreme right-hand corner is a triangular piece of lead. The picture is reduced to one-third of its original size.

The result here also showed that the organic substances are more readily penetrated than the inorganic, and that some

of these latter, notably the salts containing considerable calcium or chlorine, for example, most obstructed the passage of the rays. In many radiographs which I have taken of patients, different tissues may be recognized, owing in part to variation in chemical composition; one sees, for

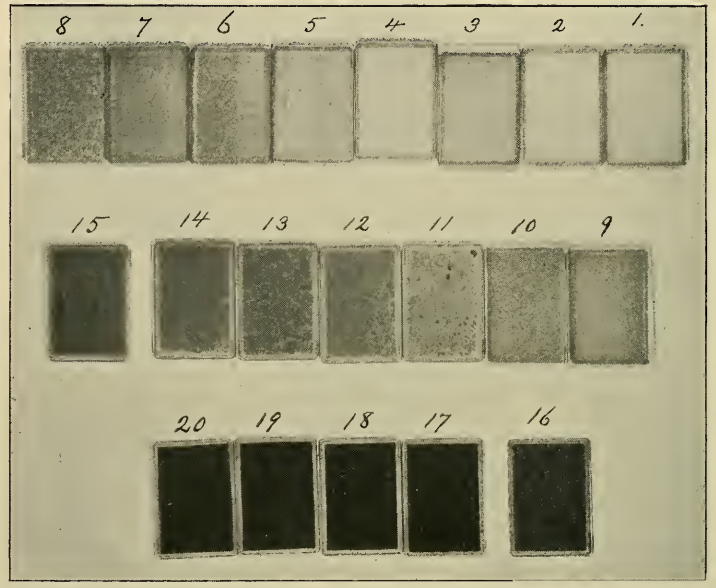

FIG. 5.—Radiograph of equal bulks of various substances which represent the constituents of the body in a general way.

	Weight.		Weight.
1. Carbonate of magnesium,	1.6 grammes.	5. Gelatin	4. grammes.
2. Stearic acid	3.8 "	6. Dried egg albumen . . .	6.4 "
3. Oleic acid	3.5 "	7. Carbonate of sodium . .	5.9 "
4. Palmitic acid	4.4 "	8. Milk sugar	11.7 "
9. Glycerine	4. grammes.	13. Phosphate of calcium . .	2.6 grammes.
10. Water	14. "	14. Sulphate of sodium . .	10.8 "
11. Oxalic acid	12.2 "	15. Magnesium ammonium phosphate	12.5 "
12. Phosphate of sodium . .	10.6 "		
16. Chloride of sodium . .	8.5 grammes.	19. Carbonate of calcium . .	15.3 grammes.
17. Sulphur	13.9 "	20. Fluoride of calcium . .	11.7 "
18. Chloride of potassium .	10.1 "		

example, the skin, a layer of adipose tissue, muscles, normal bone, and chemical changes in bones due to disease.

The radiographs[1] of the teeth first taken by Dr. Rollins show beautifully the bone of the jaw, the enamel of the tooth, the dentine, and the tooth canal. This is probably largely a question of chemical composition.

[1] "Boston Medical and Surgical Journal," Vol. 135, page 90, 1896.

Let us see what further light may be had on this subject from a chemical standpoint. It is known that the chemical elements vary, generally speaking, in the ease with which they are permeable by the rays according to their atomic weights. These weights range from 1 to 238.5. We do not find all these elements in the body, but only those, in any considerable amount, which are given with their atomic weights in Table I.

TABLE I.

Element.	Atomic weight.
Hydrogen	1.
Carbon	12.
Nitrogen	14.
Oxygen	16.
Fluorine	19.
Sodium	23.
Magnesium	24.
Phosphorus	31.
Sulphur	32.
Chlorine	35.5
Potassium	39.
Calcium	40.
Iron (to small amount only)	55.9

Further, about two-thirds of the body by weight is water (molecular weight, 18), and the soft tissues are largely made up of it.

	Water.
Ligaments contain about	77%
The voluntary muscles, about	75%
(They contain nearly one-half the water of the body.)	
Cartilage	55%
Bones	13%
Teeth	10%
Epidermis	3%

The various fluids formed in the body in health or disease, such as the blood, ascitic and pleuritic fluid, the urine, pus, fluid from hydrocele, etc., are made up chiefly of water, and are found to offer about the same resistance to the pas-

sage of the rays as does water when compared under the fluorescope. That is, the difference in the amount of light as seen in the fluorescope which passed through each of these fluids when placed respectively in a vulcanite cup, compared with an equal amount of water in a vulcanite cup, was not marked. From such observations and from our knowledge of the composition of the constituents of the body we can infer that its soft tissues, except adipose tissue, will present about the same resistance to the passage of the rays as an equal bulk of water, whereas the denser tissues which differ from water in their chemical composition and contain elements of a higher atomic weight than oxygen, the chief weight of water, will present a greater obstacle than water to the passage of the rays. It will occur to those familiar with the composition of the various tissues of the body that in some, muscle, for example, the organic constituents made up of carbon, hydrogen, and nitrogen would tend to make it more penetrable than water, whereas any small amount of mineral matter would diminish its permeability; that is, the average of the soft tissues would not be far from water.

There is one other point which must not be overlooked in this connection, and that is the difference in resistance which air and water offer to the passage of the X-rays. The rays pass through air much more readily than through water, and as air makes up a certain bulk of the body, a large part of the chest is filled with it, while water enters into the composition of all parts of the body and forms the chief constituent of the soft parts, it is readily seen of how much importance is this difference in permeability of air and water by the rays, on account of the great contrast which is thereby afforded in health between the lungs and their adjacent tissues or organs. Further, as will be shown later, one of the best opportunities for the advantageous application of the X-rays is obtained from the contrast of the normal lung tissue with that offered by pathological conditions which occur in the thorax, involving chiefly increase in density in the lungs or in the space usually occupied by them.

To use the Roentgen rays successfully in practice, it is first essential that the physician become familiar with the appearances in the fluorescope which present themselves in

health. This applies particularly to the thorax, and the picture of this part of the body when seen in the screen of a large fluorescope presents so much that it should be studied systematically. The trunk appears lighter above than below the diaphragm, and the rise and fall of this muscle, which appears dark in the fluorescope, are distinctly seen. The chest is divided vertically by an ill-defined dark band, which includes the backbone, on each side of which the lungs, forming the brightest part of the picture, are crossed by the darker ribs. The pulsating heart is seen, especially the dark ventricles, and, under favorable conditions, the lighter right auricle, and on the left side above the ventricles the pulmonary artery is made out. A small portion of one side of the arch of the aorta may be observed in the first intercostal space to the left of the sternum. After this general view has been taken, the outline of the lungs should be noted during full inspiration and expiration, and the excursion made by the diaphragm during quiet breathing and during full inspiration and expiration. The lungs usually appear brighter during deep inspiration; in young persons brighter than in older persons, as the tissues of the former are more easily penetrated by the rays. In the thin, the lungs appear lighter than in the heavy, because the outlines are dulled, as it were, by a thicker layer of tissues, which contain much water. It has seemed to me that the right apex is normally darker than the left apex. The normal brightness of the lungs and the normal outlines of the clavicles and ribs should be observed, for as we note different degrees of pallor by reference to our standard of color in health, in the same way is it necessary to know the normal amount of light which should penetrate any given part in order to recognize variations from the normal. The eye must be trained in the use of the X-rays as is the ear for auscultation and percussion. In Fig. 6 the two upper lines on either side of the chest indicate the position of the top of the diaphragm during expiration and inspiration respectively in quiet breathing; the lower on either side, the top of the diaphragm in full inspiration; the line of complete expiration nearly coincides with that of expiration in quiet breathing. The spot below the nipple is where the apex beat was felt.

The Crookes tube was directly under the junction of the ensiform cartilage with the sternum.

In six men with healthy lungs the diaphragm moved on an average two and three-fourths inches on the right side and two and one-half inches on the left side. In eighteen patients with tuberculous lungs the average excursion of the diaphragm was one and one-fourth inches. In health the diaphragm is less sharply defined in expiration than in inspiration.

The heart in some healthy persons moves in deep inspi-

FIG. 6. — Chest of man, showing diaphragm lines in quiet breathing and deep inspiration, and part of the outline of the heart.

ration downwards and toward the median line about one-half an inch.

To test the possibilities of an examination with the fluoroscope in certain conditions of the lungs, as when congestion or more or less œdema or pleurisy was present, I tried one or two simple experiments. On full inspiration in healthy patients I found the pulmonary area lighter than in other stages of respiration, and the ribs stood out in greater contrast, thus showing that there must be less blood in the lung during the former period, and that if any part of the lung is much congested, or if œdema is present, it would naturally appear darker than the normal lung; also, when I held a small pasteboard box, about one-half inch

deep and full of water, over one side of the thorax of a well-developed and muscular man with a large chest, I could see its shadow in the fluorescope during about full inspiration, but not at other times.

In order to get further suggestions in regard to the possibilities of the X-ray examinations in diseases of the lungs, I took a number of radiographs of healthy and diseased lungs just after death. As a specimen of the latter, see Fig. 7, which shows the lungs of a patient who died of pneumonia. The darker was more affected by the process than the lighter; the lightest portion is healthy. These lungs were kindly sent to me for a few moments by Prof. W. T. Councilman. The autopsy of one of my patients showed he had perfectly healthy lungs. I had examined the chest of this man with the fluorescope two days before his death, and found his lungs perfectly clear and the outlines well defined. The outlines also of the front and back portion of the ribs, forming a lattice work as shown in the fluorescope, were well seen.

We shall see later that in certain diseases parts or the whole of one or both lungs appear darker or lighter than in health, and that their volume may be greater or less than in health. The respiratory excursion of the diaphragm may vary from the normal on either or both sides of the chest, in position; that is, it may be higher or lower in the body, and in amplitude. In making examinations, changes in the amount of light seen in the fluorescope should be carefully observed; for example, whether or not one lung is darker than the other. In pathological conditions the indications of change in density, shown usually by diminished brightness, may be estimated by comparing the two sides and observing whether the outlines of the organs, and whether the ribs and clavicles, are more clearly seen on one side than the other. When both sides are diseased the opportunity for direct comparison with the normal is lost, and one is obliged to depend upon the recollection of the normal in an individual of the same build.

The position, excursion, and curve of the diaphragm should also be carefully noted. If these are normal there is little probability that the lungs are diseased; but in tuber-

culosis or pneumonia, when the lung, which should be well filled with air, is made denser by some pathological process,

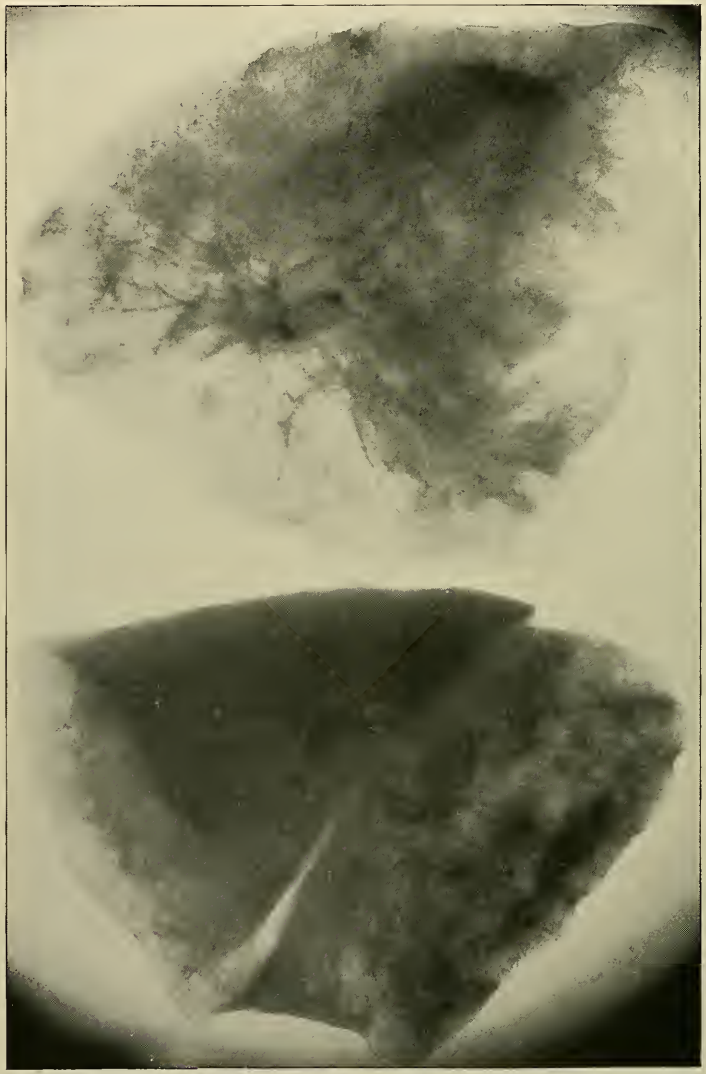

FIG. 7. — Lungs from a patient who had died of pneumonia. The darker lung has been more affected by the pneumonic process than the lighter.

or, if the elasticity of the lung is diminished, the excursion made by the diaphragm will be less than in health, and will be reduced from the lower side; that is, the diaphragm

would not reach so low a point in the chest. In emphysema, on the contrary, although the excursion of the diaphragm is also less than in health, it goes further down into the chest than when the conditions are normal. When there is fluid in the pleural cavity the outline of the diaphragm is obscured.

I have thus far considered some general principles and described a few simple experiments which have a bearing upon the practical applications of the X-rays to medical practice, and have indicated some of the inferences which may be drawn from them, and will now consider the clinical side of the subject.

By the courtesy of my colleagues of the hospital staff, under whose care most of these patients were, I give a brief outline of the physical examination of a number of them, and have added what I found by the X-ray examination. We will consider first cases of pulmonary tuberculosis. Most of these patients presented well-marked signs of the disease when they entered the hospital, but in private practice the proportion of patients who are seen in the early stages, when there is greater opportunity for successful treatment, is larger, and therefore the earlier diagnosis which the fluorescope assists us to make would be of special value in these cases.

In tuberculosis of the lungs the fluorescope indicates disease in the following ways:

A diminution in the volume of the diseased lung is shown by the position and movement of the diaphragm, and increase in density by a diminution in the normal brightness, the degree and extent varying in accordance with the increase in and extent of the density. The lung may become so dense that no more rays pass through it than through the liver. The brightness or light in the lungs indicates the amount of air present in them.

The following cases of tuberculosis taken from those I have examined, more than fifty in number, illustrate several points: Correspondence between the physical signs and the X-ray examination in a considerable number of cases; more extensive disease than was shown by the physical examination in certain cases; an earlier increase in density in the

lungs than was detected by the physical examination in still other cases; in one of these no signs in the lungs were detected prior to that found by the fluorescope, while in some, although one lung was ascertained by the physical examination to be seriously involved, its companion was not suspected until the X-ray examination revealed its increased density; fourth, three cases suggest that increase in density was not present where the physical signs intimated it. In a few cases the physical signs gave more information than the X-ray examination, but these were cases that were examined before I had had much experience in the use of the fluorescope. It will be noticed that in some of these cases nothing essential was learned by the X-ray examination that the physical examination had not already shown, but it should be said that in the beginning of my study it was instructive to examine any tuberculous patient, for if the correspondence between the physical signs and the X-ray examination had proved not to be evident in well-marked cases, it would have been useless to pursue the subject farther. At first, in order to make the X-ray examinations without bias, I examined the patients with the fluorescope before knowing anything of the physical examination. My object was to seek for any method that would assist in making a diagnosis as early as possible, and the X-ray examination is of service, to recapitulate somewhat, if it reveals to us changes in the lungs earlier than we have been able to learn of them in other ways; and if it will assist us to ascertain better than heretofore the extent to which the lungs are involved, whether to a greater or a less amount; in cases where the physical examination seems to show that the lungs are denser than normal, but the fluorescope shows that they are clear, we may be enabled by the aid of the X-rays to make a more favorable or more guarded diagnosis. Obviously, in a well-marked stage of tuberculosis of one or both lungs, it is useless to make an X-ray examination for purposes of diagnosis, although in these cases it is serviceable in estimating the extent of the disease. When no signs, or only doubtful ones, are found by auscultation and percussion, the X-ray examination should be made, and in such cases

we usually have the opportunity of comparing a diseased with a healthy lung. It should be borne in mind that in the use of the fluorescope we are not wholly dependent on the recognition of increase in density to suspect disease in a lung, but have also a way of judging whether its volume and elasticity are normal or not by observing carefully in the fluorescope the movement of the diaphragm during respirations.

Some of these tuberculous patients in whom the disease was advanced died while in the hospital, but as there were no autopsies, it has not been possible to know how far what was seen in life under the fluorescope corresponded to the appearances after death.

In the following 18 cases the examination with the fluorescope showed that the disease was more extensive than the physical examination indicated; it also showed in cases 1, 2, 3, 4, 5, 6, an earlier increase in density than was indicated by the physical examination. In cases 2, 3, 4, 5, 6, the physical examination indicated disease in one lung, but did not show that the other was likewise involved, as did the examination with the fluorescope.

In case 7 the fluorescope showed increase in density at the left apex when it was doubtful by auscultation and percussion.

In case 17 appearances in the fluorescope suggested a cavity in the upper part of the lung; the physical signs noted, after the examination with the fluorescope, corresponded with this observation.

Examination with fluorescope showed increase in density in the first six cases earlier than the physical examination:

1. M. M., 23 years. Tuberculosis. Family history tubercular. History of haemoptysis, physical examination negative except a few clicks at the junction of second rib and sternum on right, and at left apex behind.

Examination with fluorescope: Darker over three-fourths of right lung, and also at left apex to second rib; on the right side the thorax was darker than normal nearly to line of liver; on deep inspiration the lower portion of the right lung was clearer than the part above.

[Three weeks after X-ray examination there was found slight dulness at left apex back and front, with harsh respiration and increased voice-sounds.]

Examination with fluorescope showed in the following five cases that not one, but both lungs were involved:

2. B. J., 27 years. Tuberculosis. Tubercular family history. Haemoptysis. During past month dyspnoea, weakness, night-sweats, little cough. Marked signs of tuberculosis below second rib over whole left side; right lung negative.

Examination with fluorescope: Whole of left lung much darker than normal, no heart outline, no diaphragm outline seen on left side. Right apex darker than normal to lower border of second rib.

3. L. C., 44 years. Tuberculosis. Dulness, with râles over left side down to third rib in front and middle of scapula behind.

Examination with fluorescope: Somewhat darker at both apices down to lower border of third rib, and to some extent below; excursion of diaphragm much less than normal, ⅞ inch on right side, ¾ inch on left.

4. H. A., 20 years. Tuberculosis(?) Duration, four weeks; family history not tubercular. Medium dry râles at left apex, with slight dulness; right apex normal.

Examination with fluorescope: Left lung extending to level of the fourth rib very dark; there is also some involvement of right apex. The maximum respiratory movement of the diaphragm on the left side is only ¾ inch; on the right side 1 inch only. This is less than half the normal.

[Later tubercle bacilli were found.]

5. R. J. M., 44 years. Anorexia; loss of flesh; percussion, dulness at right apex, front and back, to third space and middle of scapula; expiration prolonged, râles; increased voice-sounds; left side normal.

Examination with fluorescope: Right lung darker to fifth rib; left lung darker than normal as far as second rib.

[Tubercle bacilli found later.]

6. S. S., 35 years. Tuberculosis. Mitral stenosis. A few scattered sonorous râles. In left back from 1 inch below angle of scapula are many fine and medium moist râles. Two negative examinations for tubercle bacilli.

Examination with fluorescope: Right lung to level of nipple darker than lower portion of right lung; whole of right lung denser than left lung. Left lung at apex (to second rib) rather darker than normal; lower part of left lung the clearest part of the chest.

7. R. M., 24 years. Pleurisy +. Signs in right apex and friction rub at right base, a question of left apex; slight haemoptysis.

Examination with fluorescope: Both apices darker to third rib on right side, not so far on left. [Five weeks later dulness in both apices, more in the right apex.]

8. F. J., 26 years. Tuberculosis. Marked dulness of right apex above clavicle; less dull to third rib; increased voice-sounds; respiration slightly harsh; expiration prolonged; moist râles at apex.

Examination with fluorescope: Whole of right side darker than left side, especially upper half of right lung; ribs in upper half of right chest seen very indistinctly; ribs seen very clearly on left side; outline of diaphragm distinct on left side during expiration; outline of diaphragm not distinct on right side; in fact, not well made out.

9. L. J., 23 years. Tuberculosis(?) Family history tubercular. Haemoptysis. Lost fifteen pounds; dulness under right clavicle, with fine moist râles after cough; practically no other abnormal signs.

Fluorescope: Increased darkness on right side to lower border of third rib; also on left side darker than normal.

10. T. M., 34 years. Tuberculosis. Night-sweats and loss of flesh; fair resonance over both fronts; over upper third of right front respiration is rather harsh; on the left above the clavicle and down to fifth rib are numerous coarse, moist râles; left back: resonance somewhat deficient throughout.

Examination with fluorescope: Both apices darker than normal to upper border of third rib on right, and to upper border of fifth rib on left side; outlines of ribs at apices not defined; left border of heart not defined on account of increased density of lung.

11. M. W., 17 years. Family history tubercular. Duration, six months. Right apex dull above second rib in front and angle of scapula behind; expiration slightly prolonged; mostly dry râles in this region; voice-sounds, especially at right apex in front, increased; râles of same character in left upper front.

Examination with fluorescope: On right side darker than on left from second to fourth rib; diaphragm moves on right side 1 inch, on left 1¼.

12. G. H. Tuberculosis. Both apices dull in front; right more so behind; respirations harsh, moist and dry clicks after cough; tubercle bacilli found.

Examination with fluorescope: Upper half of right lung darker than normal, and apex of left lung.

13. N. E. Tuberculosis. Tubercle bacilli found; deficient resonance over left front; fine crepitations over lower half of right axilla, over upper two-thirds of scapula, and between scapula and spine; numerous squeaks which seem close to the ear; a few also heard between border of right scapula and spinal column; few fine râles at right base.

Examination with fluorescope: Whole of both lungs somewhat darker than normal; the darkest portions are from right apex to second rib, left apex to third rib.

14. P. D., 48 years. Tuberculosis. Duration, two months. Fair resonance over both lungs except at left base behind, where there is slight

dulness; respiration somewhat jerky over upper half of both fronts, slightly bronchial over upper half of left; over left front to the fifth rib are numerous medium and fine moist râles after cough; a few râles over upper right front; at left base are numerous fine crepitations Tubercle bacilli found.

Examination with fluorescope: Left lung darker throughout than right; outline of diaphragm and of heart on left side ill-defined; lower portion of left lung (below a line running directly outwards from junction of fifth rib and sternum) is much darker than above this.

15. D. J. D., 32 years. Tuberculosis(?) Bronchitis. Pleurisy. Considerable expectoration, loss of flesh, pain in left side, flatness at left apex above the clavicle; a little dulness just below outer end of left clavicle; slight dulness above right clavicle; patient breathes feebly on account of pain in lower left chest; increased vocal resonance at left apex, and in small patch below and just outside right nipple; moist râles throughout upper left chest.

Examination with fluorescope: Left side a little darker than right side down to third rib; movement of diaphragm on left side ¾ inch, on right side 2½ inches.

16. C. M., 45 years. Tuberculosis. Fair resonance over right chest, some dulness over left chest, with many fine, moist, sonorous, and sibilant râles, also occasional coarse moist râles; slight increase in vocal fremitus throughout the left side and whole upper chest front and back.

Examination with fluorescope: Left apex as far as lower border of second rib is a little darker than corresponding portion of right side. Diaphragm on right side moves 2½ inches, on left 1¾.

Second examination with fluorescope, seven weeks later: Right clavicle seen only indistinctly; first and second ribs seen less distinctly than normal; diaphragm moves 2¼; left, no clavicle seen; first and second ribs indistinctly; diaphragm moves 1¾.

17. G. A., 35 years. Tuberculosis. Good resonance on right chest except at apex, where resonance is lacking; breathing is rather high pitched, and there is an occasional crackling râle after cough; left lung resonance high pitched at apex, becoming markedly dull below on front and back; breathing, broncho-vesicular; increased tactile and vocal fremitus and whispered bronchophony; numerous fine, moist, and crepitant râles over whole chest. Tubercle bacilli found.

Examination with fluorescope. On right side from apex to lower border of fifth rib the lung is darker than normal, though the outlines of the ribs are seen. On the left side the lung is dark throughout except between the first and third ribs, where there is a light area which suggested a cavity. The left border of the heart is not seen; the diaphragm on the left side is barely made out.

After the X-ray examination another physical examination gave: left apex: percussion rather high-pitched and tympanitic in quality; breathing amphoric.

18. T. H., 32 years. Ill fifteen days before entrance to hospital; never been ill before. At entrance sputum appears to be merely saliva — no signs in lungs; seventeen days after entrance, dulness at left apex to third rib; prolonged and harsh respiration. Left back: dulness above spine of scapula; harsh breathing; voice-sounds increased; fine crackling râles after cough.

Examination with fluorescope: Left lung dark from apex to fourth rib; outline of heart above fourth rib and the ribs themselves barely visible. Diaphragm moved 1 inch on left side, and 2 inches on the right side.

The following seven cases show a general correspondence between the physical examination and the examination with the fluorescope:

19. C. F. W., 21 years. Tuberculosis. Duration, two and a half years. Right side: marked dulness in front to second space, where note becomes higher pitched. At second space respiration somewhat amphoric, with loud crackling râles and metallic tinkling at times; fine râles to base; fremitus and voice-sounds increased throughout; in back, dulness from apex nearly to base. Left side: resonance slightly diminished at extreme apex front and back, with dry râles in front.

Examination with fluorescope: Right side dark to lower border of fifth rib in mammary line. Left side clear except at apex, but as right side is dark, there is no opportunity for comparison with normal. Diaphragm on right side moves ¾ inch only; on left side, 1¼ inches only.

20. M. J., 44 years. Tuberculosis. Lungs: slight dulness at right apex in supra-clavicular space; high-pitched breathing; occasional crackling râles after cough; left side: in front, marked dulness at apex and in left axilla, with percussion note lacking over rest of left front; at apex, breathing is broncho-vesicular with increased vocal and tactile fremitus; numerous fine, moist, and crackling râles.

Examination with fluorescope: Difficult to estimate condition of right apex, as there is no opportunity for comparison with the normal; whole of left side darker than normal. First, second, third, and fourth ribs and clavicle not seen; below this ribs faintly seen. Diaphragm only faintly seen on left side; moves right side only 1½ inches.

21. C. J., 29 years. Tuberculosis. Dulness over right lung down to fourth rib in front and as far as spine of scapula in back; broncho-vesicular breathing; increased vocal and tactile fremitus; bronchophony; numerous fine, moist râles.

Examination with fluorescope: Right side darker to third rib, very marked; moves diaphragm right side ¾ inch, left side 1½ inches.

22. L. C. F., 24 years. Had pleurisy on left side two weeks ago. Pulmonary tuberculosis. Right side negative; left, slightly diminished resonance throughout lower half of left back; voice and fremitus also

diminished, with occasional friction; no râles heard; rest of lung negative. Tubercle bacilli found.

Examination with fluorescope: Right apex seems a little darker than left apex as far as lower border of second rib; diaphragm moves 1⅞ inches on right side, 1⅛ on left side; outline of diaphragm on the left not quite as clear as on right side.

23. H. J., 33 years. Cough one year. Pain in lower front chest; slight dulness at left apex, front and back; occasional râles; voice-sounds slightly increased; prolonged expiration. Tubercle bacilli found.

Fluorescope: One week later, upper part of both right and left chest darker as far as second rib; clavicles and first and second ribs not seen; movement of diaphragm on right side, 2¼ inches; on left side, 1½ inches.

24. C. J., 33 years. Tuberculosis. Duration of illness, two months. Right front by percussion tympanitic; respiration diminished; few râles scattered throughout; tactile fremitus diminished; right back: dulness from apex to one inch below angle of scapula; fremitus same as left side; respiration diminished throughout, less marked from angle down; few fine râles over upper half; entire right back is dull, dulness increasing downwards; left front negative save for few sonorous râles at base; tubercle bacilli found.

Examination with fluorescope: Right side much darker than left side, which is clear and bright; the darker area extends over whole of right side.

25. B. M., 30 years. Tuberculosis, haemoptysis. Tubercle bacilli. Left lung: dulness in front second rib, with bronchial respiration, and a few fine râles throughout the left back; dulness also in lower left back; increased vocal fremitus; right lung free except for small patch in back, opposite fourth dorsal vertebra, over which are heard bronchial breathing and occasional fine râles.

Examination with fluorescope: Left lung darker from apex to fourth rib; right lung darker from apex to lower border of second rib.

Examination with the fluorescope suggested a more favorable condition than was indicated by the physical signs:

26. N. O., 27 years. Tuberculosis (?) Resonance and respiration fair on both backs; right back below spine of scapula, dulness; breathing diminished; vocal and tactile fremitus increased slightly; occasional râles.

Examination with fluorescope: Both sides clear.

27. M. C., 29 years. Tuberculosis (?) Loss of flesh and appetite; for six weeks cough and expectoration; no dyspnoea, no night-sweats. Three examinations for tubercle bacilli negative.

Examination with fluorescope: No difference in two sides; rays

go through both chests well; outlines of diaphragm and heart show clearly.

Later the signs of bronchitis cleared up.

28. S. B., 20 years. Diagnosis: phthisis. May 1, 1894, pain in chest, subject to colds; weak amenorrhoea, signs of consolidation at both apices, especially the left; numerous fine and medium râles. October 16, 1894, signs at both apices; weight, 105½ pounds. December, 1894, weight, 105 pounds. July, 1895, slight dulness at both apices, front and back; few râles; weight, 102 pounds. September, 1896, cold hands and feet; no cough; pain in chest, side, and back, especially after taking any food or drink; patient is very nervous woman.

Examination with fluorescope: No difference in the two sides, both clear; ribs and clavicles stand out clearly.

In the following cases the examination with the fluorescope gave less information than the physical examination:

29. B. J., 42 years. Tuberculosis. Dulness in both supra-clavicular spaces, especially the left; left back dull above the spine of the scapula; below left clavicle some slight dulness with high-pitched breathing, tubular in character with prolonged expiration; vocal and tactile fremitus increased; numerous crackling râles; right apex, dulness to supra-clavicular space; occasional râle at right apex.

Examination with fluorescope: Left apex darker than right apex; no increased darkness detected at right apex; probably not as readily noticed, as the left side is already diseased, and therefore comparison with a normal lung could not be made.

30. L. M. Tuberculosis. Tubercular family history. Haemoptysis, cough, pyrexia; dulness in right front down to fourth rib, with prolonged expiration, increased voice-sounds, fine crackling râles, most marked after cough; dulness over whole right back, with increased tactile and vocal fremitus; left apex dull in front and behind, with high-pitched respiration and crackling râles.

Examination with fluorescope: Both apices darker than normal; darkness more extensive in the right side.

Pneumonia offers an opportunity of testing the value of the X-rays in recognizing increase in density in comparison with the usual physical examination. I have examined patients while they were convalescing from pneumonia, both by auscultation and percussion and by the fluorescope on the same day, and while by means of the latter I was able to recognize that the lungs were denser than normal, I failed to detect the continued increase in density by auscultation and percussion. As the lungs improved the areas that had

been dark became lighter in the fluorescope, until finally the amount of light passing through them appeared about normal. During all this time the movement of the diaphragm was less than normal; that is, the expansion of the lungs was restricted, but increased as the condition of the lungs improved. When I could no longer recognize increase in density in the lungs with the fluorescope, I could easily see by means of this instrument that the diaphragm did not descend to its normal limit, thus showing that the lungs were still in an abnormal condition. Later, the normal limit was reached.

The following cases of pneumonia taken from those I have examined show a general correspondence between the physical signs and what was seen in the fluorescope, but the brief description of these cases does not present to the mind how much these examinations conduce to a more accurate estimate of the condition of the lungs in some cases than has hitherto been possible in any other way. This method of examination enables us to judge better than any other way when the lungs have "cleared up" after an attack of pneumonia, and I am satisfied that it gives us the means of recognizing an increased density in the lungs in pneumonia earlier than has been previously possible:

1. B. G., 36 years. Pneumonia. Ten days before entrance to hospital, sudden pain in left axilla, cough, dyspnoea, fever. Physical examination at entrance showed that there was dulness in left back one inch below spine of scapula, which extended downward and outward to axilla; over dull area bronchial breathing, increased voice-sounds, and tactile fremitus; numerous fine râles after cough; resonance good over both fronts and axillae. Physical examination nine days later, at time of X-ray examination, showed dulness in left back from mid-scapula down, with bronchial breathing, increased voice-sounds, and a few medium râles.

Examination with fluorescope: Left side from third rib downwards so dense that no outline of heart, ribs, or diaphragm is to be seen. The apex of the heart, although not seen, is felt in normal position, showing that the increased density observed in the fluorescope is due to changes in the lungs rather than to fluid in the pleural cavity; right side perfectly clear, ribs and outline of diaphragm seen well.

2. L. B., 19 years. Pneumonia. At entrance to hospital, on the fifth day of the disease, marked dulness over upper right chest, down to fourth rib. Bronchial breathing, increased vocal and tactile fremi-

tus, dulness in right axilla. Right back: dulness from apex to middle of scapula. Left: front and back good resonance: many fine, coarse, and moist râles at base and back. On seventh day of the disease, right front dull from apex to lower border of second rib, shading to lower border of third rib; in back, dull to 2 inches below spine of scapula. Nineteenth day of disease, physical signs have cleared up.

Examination with fluorescope: On seventh day of disease, right lung dark from middle of first intercostal space to fourth rib; the upper and lower border of this dark area were definitely marked; outlines in chest rather less clear than normal on both sides. Diaphragm moved ¾ inch on right side, and 1⅝ inches on left side. Fifteenth day of disease, diaphragm moved 1 inch on the right side; 2½ inches on left side. Nineteenth day of disease, diaphragm moved 2 inches on right side; 2¾ inches on left side. Original dark area on right side not so bright as other portions of the lung. On the twenty-second day of the disease, diaphragm moved 2½ inches on right side, and 3 inches on left side.

3. Q. T. D., 32 years. Pneumonia. Three days before entrance to hospital, pain in right side and back and across the chest. Chills, sweating, fever, some dyspnoea. At entrance, slight dulness in right lower back, and diminished breathing at extreme base. Few fine and coarse moist râles scattered over both backs; otherwise good respiration and resonance over all. A few days later, expectoration rusty. Diagnosis before entrance to hospital was pleurisy with effusion.

Examination with fluorescope: Upper lobe of right lung darker than normal. Left side clear. Diaphragm moved 1 inch on right side; 2¾ inches on left side. Four days later, movement on the right side was 3 inches; on left side, 2¾ inches. Right side perfectly clear. Auscultation and percussion did not show the location of the disease, but it was revealed by the fluorescope. It was largely a central pneumonia.

4. C. A., 27 years. Pneumonia in the upper portion of right side. Eighteen days after entrance to hospital, percussion over front of the chest on both sides was good. In the right back, fremitus slightly increased from apex to angle of scapula; respiratory murmur shorter and fainter than on left. Respiration below angle of scapula on the right side better than above. Percussion over right and left back good.

Examination with fluorescope: Eighteen days after entrance, whole of right side darker than left side; outline of ribs seen only faintly; diaphragm moved ½ inch. Left side rather darker than normal, from second to fourth ribs; diaphragm moved 1⅛ inches. Two days later, right side not quite so clear as left; diaphragm moved 1½ inches on right side, and 2 inches on left side.

5. S. N. Pneumonia. Attack began one week before entrance to hospital. Two weeks after entrance: Dulness in right back from middle scapula down, and in axilla from fourth rib down; breathing somewhat bronchial; numerous coarse and medium râles; voice-sounds increased over this area.

Examination with the fluorescope: Right side less clear throughout than the left side, but especially below the lower border of second rib, where the outlines of the ribs are much less clear, the outline of the diaphragm is not seen. Left side clear; outline of heart, ribs, and diaphragm well defined.

6. G. W., 23 years. Pneumonia of left lower lobe. Attack began three days before entrance to hospital. At entrance, dulness in left back from 1½ inches above angle of scapula, this line of dulness extending down and out to axilla at the seventh rib; over dull area bronchial breathing, tactile fremitus, and increased voice-sounds; no râles. Six days after entrance, at time of X-ray examination, breathing a little diminished at lower part of left back; fine râles at extreme base in front, in axilla, and in back; night-sweats; loss of flesh; haemoptysis.

Examination with the fluorescope: Left side darker than normal below the level of the fifth rib in mammary line; outline of heart on left side obscured, and outline of diaphragm not clearly made out; right side darker than normal from second to fourth rib.

7. C. J. Pneumonia. Attack began one week before entrance to hospital. At entrance, slight dulness in right back from angle of scapula down, with fairly numerous medium and fine râles; one week later, breathing over lower third of right back diminished, which is dull to percussion.

Examination with the fluorescope: Right side below lower border of third rib darker than normal; outline of diaphragm on right side barely visible; on left side very clear.

In the following case what was found at autopsy confirmed what was seen in the fluorescope:

8. S. J., 61 years. Examination with fluorescope: Apex of right lung not as clear as lower part. Left side dark throughout; no outlines of heart, rib, or diaphragm seen; right border of heart two inches to right of sternum.

Autopsy, one week later: In upper lobe of right lung, the tissue retracted; in apex, small caseous nodule found; pericardium dilated, filled with opaque yellowish fluid, and extended to right nipple line; heart enlarged in all its cavities. Left lung: entire posterior portion of lower lobe and large portion of upper lobe in a state of red pneumonic consolidation.

The observations already referred to, namely, that the amount of rays passing through the lungs on to the screen of a fluorescope is not the same throughout the whole of the respiratory cycle, that so small an amount of water as ½ inch

obstructs the passage of the X-rays sufficiently to be seen in the fluorescope, the radiographs of the diseased lungs, and the cases I have given, demonstrate that we can recognize increase in density in the lungs by means of the X-rays, and therefore their serviceableness in lung diseases. The clinical test is, of course, the crucial one. The abnormal condition of the lungs in tuberculosis and pneumonia may be shown not only by the obstruction which they offer to the passage of the rays, but also by the restriction of the excursion of the diaphragm. In some cases the latter is a more delicate test.

In pleurisy with effusion we can estimate the amount of fluid in a general way by the amount of light which passes through the thorax. When the effusion is large no more rays pass through it than through the liver, and the outlines of the diaphragm, ribs, and heart are obliterated on the side of the effusion. If there is a smaller amount of fluid the outlines of some of the upper ribs are seen, and with a small effusion the outlines low down in the thorax only are ill-defined. The fluorescope assists us to distinguish between an effusion and a thickened pleura. In some cases of effusion the fluorescope shows us displacement of the heart, to the left when there is a large effusion on the right side, and a much greater displacement to the right, and this displacement is of more frequent occurrence, when the effusion is on the left side. This displacement of the heart to the right may not be recognized by percussion even when it has been pushed much beyond its normal place. In one patient the heart was seen to be displaced more than two inches to the right, but no displacement was detected by percussion. While examining some cases of pleurisy with effusion by the fluorescope, I have found indications of tuberculosis in the lung where it was not previously suspected.

Sixteen cases of pleurisy with effusion, seven on the left and nine on the right side, and one dry pleurisy.

In one of the seven cases of pleurisy on the left side the

examination with the fluorescope showed that the heart was not displaced to the right, in five that it was displaced to the right, and in one there was no record.

In six of the nine cases of pleurisy on the right side the examination with the fluorescope showed that the heart was not displaced, in two that it was displaced, and in one there was no record.

In Cases 5 and 8 the increased density of the lung and the limited excursion of the diaphragm suggest tuberculosis.

In Case 9 the diagnosis by physical examination was pleurisy with effusion or thickened membrane, the examination with the fluorescope showed that it was pleurisy with effusion.

Five cases of pleurisy on left side with displaced heart:

1. D. J., 40 years. Pleurisy with effusion. November 4, three pints drawn from left side. Left side, dulness begins at second rib in front, becoming flat at fifth rib; dulness in back at spine of scapula; flatness at angle of scapula; breathing and tactile fremitus lost just above angle; right side normal.

Examination with fluorescope: November 9, whole of left side dark, no ribs seen, neither is the heart nor the outline of diaphragm. Right side: apex darker than normal above second rib; movement of diaphragm 2¼ inches; right border of heart displaced 2½ inches to right of sternal border. This condition percussion did not show.

2. V. H., 13 years. Dulness over left front from third rib down; hyper-resonant above third rib; dulness throughout left axilla, becoming flatness over lower half; in axilla voice-sounds and tactile fremitus are diminished over dull and lost over flat area; dulness in left back from spine of scapula, becoming flatness at about the angle; tactile fremitus diminished over dull area; voice-sounds increased, whispered and spoken sounds heard distinctly to base; breathing somewhat diminished, but bronchial in character, and heard nearly to base; left side, a few coarse râles over upper left front; no râles in back; numerous fine crepitations in lower right axilla.

Examination with fluorescope: Left side dark; outline of heart and diaphragm not seen on left side; only first and second ribs seen. Right side, outline of ribs and diaphragm seen clearly; heart displaced to right, extends 2½ inches to right of sternum. Fourteen days later, left side clear above outline of left border of heart, which is faintly seen; heart not displaced.

3. B. G., 21 years. Pleurisy with effusion. Dulness on left side in front from third rib; in back, from mid-scapula, becoming flatness at

angle. In back, breathing and tactile fremitus are diminished from above downward, being lost about 1 inch below angle of scapula: voice-sounds heard faintly nearly to base. Heart: apex not felt; left border not determined; right side of heart is at right sternal border.

Examination with fluoroscope: Right side normal; left side dark below second rib; no outline of ribs, heart, or diaphragm to be seen; heart displaced to the right 1¼ inches beyond the sternal border on a level with the nipple. This fact could not be made out by percussion; there was good resonance by percussion up to and rather inside of right sternal border.

4. G. J., 24 years. Pleurisy with effusion. On left front and axilla dulness below fourth rib; in the back, dulness beginning an inch above angle of scapula; voice-sounds in breathing heard faintly nearly to base; tactile fremitus lost at angle of scapula; on the right side cardiac area extends to 1 inch of right of sternal border.

Examination with fluoroscope: Whole of left side darker than right side; no ribs seen except faintly at top of chest; no outline of left side of heart or of diaphragm seen on left side. Heart displaced to right.

5. A. C., 35 years. Pleurisy with effusion. Right lung hyper-resonant throughout; somewhat exaggerated respiration; sonorous, coarse, and moist râles. Left apex: diminished resonance from apex, front and back, increasing to flatness at third space in front, at fourth rib in axilla, 1 inch below spine of scapula in back, fremitus marked above; respiration diminished above, and lost just below line of flatness; friction sounds in back from spine of scapula nearly to angle of same.

Examination with fluoroscope: Right side clear except at apex, as far as second rib, where it is less clear than normal. The diaphragm moves 1¼ inches between full inspiration and complete expiration. Heart displaced to the right 1 inch beyond right border of the sternum. The increased density of the lung at the apex and the limited excursion of the diaphragm suggest tuberculosis. Left side dark; clavicle and first rib seen faintly; no outline of heart or diaphragm.

Pleurisy of left side, heart not displaced:

6. H. J., 15 years. Pleurisy with effusion. October 3, dulness an inch below angle of scapula on left side. October 10, fair resonance to tenth rib; few friction rubs still heard. Respiration heard to extreme base.

Examination with fluoroscope, October 8: Outline of diaphragm on left side not quite so clear as on right side. Heart not displaced.

7. N. S. Pleurisy with effusion. Two days previous to X-ray examination with fluoroscope one quart of clear fluid was drawn from left pleura.

Examination with fluoroscope: Left chest above fourth rib darker than normal; below this rib outline of heart and diaphragm hardly visible.

Two cases of pleurisy on right side, with displaced heart:

8. B. D., 31 years. Pleurisy with effusion. Right side, dulness from second space in front and below spine of scapula behind, becoming flat; voice-sounds and fremitus diminished over dull area and absent over flat area; relative dulness from left edge of sternum to just inside nipple line; left lung somewhat hyper-resonant throughout; otherwise negative.

Examination with fluorescope: Right side dark throughout. From apex to diaphragm, ribs barely suggested in the middle of the thorax; darkness on the right side nearly the same as that of the hepatic area; left border of heart ¼ of an inch outside the mammary line; left side: apex to fourth rib dark; diaphragm moves 1½ inches only. The diminished excursion of the diaphragm and the increased density of apex of left lung suggest tuberculosis.

9. M. P. Pleurisy with effusion or thickened membrane

Examination with fluorescope: Right side much darker than left side; ribs not seen below the third rib; outline of diaphragm not seen; heart displaced to left. This examination shows the presence of fluid.

Six cases of pleurisy of right side, heart not displaced.

10. H. N., 59 years. Pleurisy with effusion. Tapped three weeks previously; thirty-seven ounces withdrawn. Right front, flatness from fourth rib down; fremitus lost at sixth rib; distant breathing heard to base; flatness at right back to angle of scapula; breathing and fremitus lost at angle.

Examination with fluorescope: Right chest darker throughout; no outline of ribs or diaphragm seen; left side normal; heart not displaced; diaphragm moves 2½ inches.

11. P. A., 19 years. Dulness in right chest from third rib downward in front, and in axilla, and from mid-scapula downward in back; breathing, tactile fremitus and voice sounds diminished over lower part of dull area; friction rubs heard over upper third of right front.

Examination with fluorescope: Right side dark; neither ribs nor diaphragm seen; heart not displaced to left; left side clear.

12. C. J., 37 years. Pleurisy with effusion. Dulness at both apices in front, with broncho-vesicular breathing; increased vocal resonance and a few crackling râles, especially after cough; dulness over right back, becoming flat 3 inches above angle of scapula; over the upper portion of the lung numerous fine râles; spoken and whispered sounds increased; over the flat area breathing is diminished and nearly absent at base, with diminished vocal and tactile fremitus; dulness in right axilla below fourth rib, with diminished breathing; good resonance and respiration over right front.

Examination with fluorescope: Right side dark, ribs only faintly indi-

cated throughout right chest; outline of diaphragm not seen on right side. Left side clear, heart not displaced, the left border and apex clearly marked.

13. G. M., 23 years. Pleurisy with effusion. Good resonance and respiration over left chest; dulness over whole of right chest, with flatness below the third rib in front and 1 inch below spine of scapula in back; right side, at apex, breathing is bronchial, with crackling and a few moist râles; below, breathing becomes distant, and is nearly absent at the base; a few fine rubbing sounds are heard over the right chest.

Examination with fluorescope, November 5: Left chest normal; right chest, first and second ribs seen faintly; no outline of diaphragm seen; below fourth rib, chest about as dark as the hepatic area; liver not displaced downward; heart not displaced to left. November 12, left chest normal; right chest, outlines of first, second, and fourth ribs seen; outline of diaphragm not seen.

14. G. J., 43 years. Pleurisy with effusion. Dulness, right side below third interspace in front, soon running into flatness; behind dulness begins about mid-scapula; left side negative.

Examination with fluorescope: Right side, first and second ribs seen, but not very distinctly, and no outline of diaphragm; heart not displaced to left; left side normal; ribs and spleen and heart seen well.

15. E. C. Pleurisy with effusion. Dulness from spine of scapula on right and below fifth space in front; visible respiration almost entirely on left side; heart not displaced.

Examination with fluorescope: Whole of right side darker than left side; border of the diaphragm on the right side is not so well marked as on the left side, where it is clearly defined; ribs on right side do not stand out so distinctly as on left side.

16. H. E. M. Pleurisy with effusion. The day before the X-ray examination was made the chest was tapped and about one quart of fluid was drawn off from right side.

Examination with fluorescope: Right side darker than left side, but not uniform in character. The area above an imaginary line running from the point where the cartilage of the sixth rib joins the sternum to the outer end of the clavicle, although darker than the left side, was lighter than the area below this line. Percussion showed less dulness above this line than below it. The outline of the diaphragm on the right side was indistinctly seen. No record as to heart.

17. D. D. Dry pleurisy on left side.

Examination with fluorescope: Both sides of chest equally clear. The diaphragm moves well in respiration.

Two thoracic aneurisms are represented in the figures 8, 8′, 9 and 9′ by lines on the skin which follow the outlines as

Fig. 8.— Aneurism — front of chest.

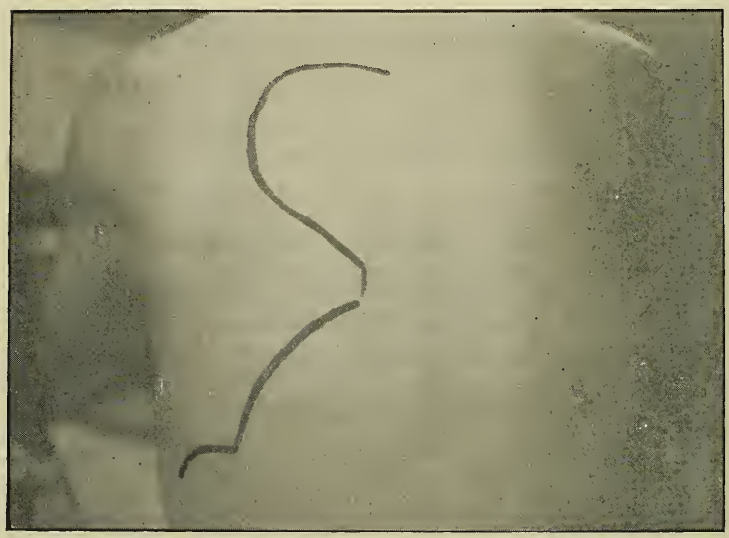

Fig. 8 . — Aneurism — back.

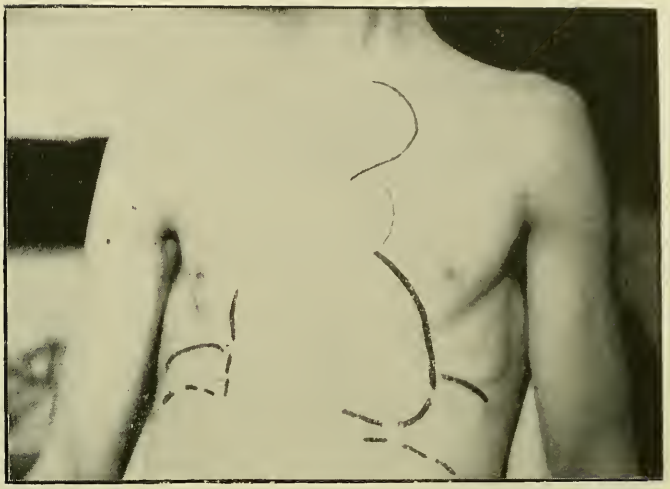

Fig. 9. — Aneurism — front.

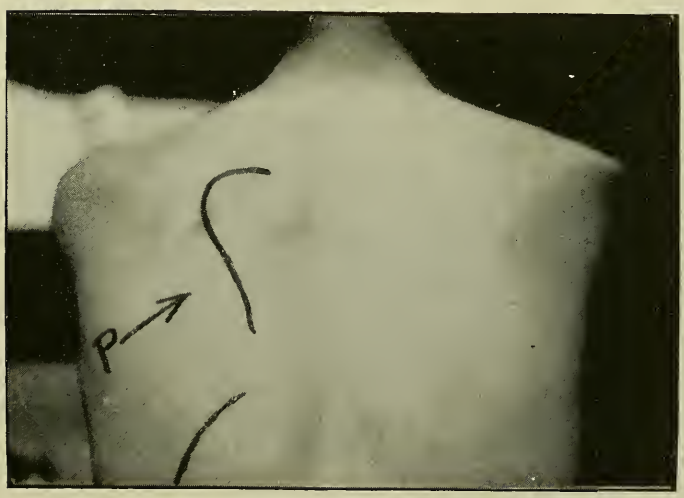

Fig. 9'. — Aneurism — back.

seen in the fluorescope. The heart in three of the thoracic cases given below is much displaced. Aneurisms of the arch of the aorta are most clearly outlined when their borders are nearest the fluorescope; those on the left when examined from the back, those on the right when examined from the front. It is obvious that aneurisms of the thoracic aorta can sometimes be detected earlier by X-ray examination than in any other way. In obscure thoracic cases where an aneurism of certain portions of the aorta is suspected, but does not exist, it may probably be excluded by an X-ray examination.

M. J., 59 years. Aneurism. About four years ago the patient suddenly became unconscious for about one minute without warning; recovery was immediate. About one year ago he began to be hoarse, and this hoarseness grew rapidly worse; about the same time, while running, he had marked dyspnoea; this symptom has increased; can walk some distance if careful. About three months ago he first raised a little rather dark blood, and has continued to raise a little blood since then, especially after talking. Within the past months has had short and sharp attacks of pain, starting in the pit of the stomach, radiating to left shoulder, and down left arm to elbow. There is numbness of left arm associated with this pain; voice is shrill and husky; left vocal chord is paralyzed and fixed in the median line; arteries somewhat tortuous and resistant; heart's area decidedly diminished (emphysema); action regular and fairly strong; apex beat in nipple line; first sound in aortic area is rough; second sound is ringing and valvular; resonance of lungs somewhat exaggerated; over upper half of left chest there is respiratory murmur; vocal fremitus and voice-sounds are diminished, especially in front; percussion not modified; faint pulsation to be felt by pressing the chest between the two hands; seems most marked at junction of second rib with sternum.

Examination with fluorescope: The curved lines in the upper part of patient's left chest (see Figs. 8 and 8′), both front and back, and the curved line on his right chest, indicate the outline of the aneurism as seen in the fluorescope. The lower curved lines on his left chest, front and back, mark the outline of the heart; the lowest curve on the left back and the right front, part of the outline of the diaphragm; the dotted line, the cardiac area as determined by percussion. This shows how a large aneurism may exist in the chest without giving rise to physical signs. Some weeks after the return home of the patient he took a twenty-mile drive, contrary to the direction of his physician, immediately after which the aneurism burst, and he died in a moment.

F. K. Aneurism. The illustration of this aneurism is not given; its character was similar to that of M. J.

C. S. T. Aneurism: Four months previous to entrance to hospital the patient complained of pain in the right shoulder and elbow, which was followed a week or two later by pain in the chest over a pulsating area on the right side in front.

Examination with fluorescope: The aneurism in front on the right side was easily recognized by percussion, but on the left side in front there was no dulness to percussion over this area of the aneurism, but it was seen in the fluorescope. The presence of the aneurism was obvious, but its extent could only be determined by the fluorescope.

K. B., 44 years. (A patient of Dr. F. C. Cobb, kindly referred to me by Dr. E. C. Codman.) Aneurism. Lost his voice very suddenly about two weeks before he was examined; has pain in left shoulder for two or three seconds at a time.

Examination with fluorescope (see Figs. 9 and 9′): The upper curved line, front and back, marks the outlines of the aneurism as seen through the fluorescope, and were drawn by me on the patient's chest. In the view of the back (Fig. 9′) the arrow marked P indicates the point where pulsation was most marked; the right and left border of the heart are also marked on the chest (Fig. 9), and the left border in the back (Fig. 9′); the parallel lines drawn on the chest in front are the outlines of the diaphragm in full inspiration and complete expiration.

C. A., 40 years. Aneurism. Pulsation seen and felt in the lower part of the neck above and behind the inner end of the right clavicle. There was evidently an aneurism of the subclavian artery. An operation was advised, but before this was done an X-ray examination was made in order to determine the lower limit of the aneurism and ascertain if it extended to the larger arteries below; in which case an operation would be more serious, or it might be necessary to abandon it altogether.

Examination with the fluorescope: No indication of any aneurism extending below the lower border of the clavicle. A radiograph showed the outline of the aneurism in the neck, but also gave no indication of any below the clavicle. Both sides of the chest were equally clear, thus showing there was no aneurism there. Operation for ligaturing the innominate artery confirmed the observations made by X-ray examination.

The position and size of the heart are not always indicated correctly by percussion, and the apex beat cannot always be felt, and even where this is readily felt X-ray examinations show that it does not correspond in all cases to the apex of the heart as seen in the fluorescope. The lower border of the heart cannot be obtained by percussion, but can be seen in the fluorescope during deep inspiration; in some patients nearly the whole outline of the ventricles can be seen. The right and left border of the heart may

usually be more correctly determined by the fluorescope than by other means.

In some cases of emphysema the outline of the heart is not found by the ordinary examination, but is seen with more than normal clearness by the X-ray examination. If in some cases we are unable to establish the position of the heart exactly by auscultation and percussion, it is obvious that we may be still less able to determine its size. In studying diseases of the heart, the fluorescope is of assistance in determining its size and position, also in determining increase in density of the lungs due to oedema or marked congestion, the result of cardiac or other diseases. The fluorescope may show that the lungs of a patient suffering from cardiac disease or dyspnoea on exertion are less clear than normal, and after suitable treatment the dyspnoea disappears and the lungs become clear, thus confirming the information obtained by the fluorescope.

The Roentgen rays enable us, then, to gain a better knowledge of the size and position of the heart, and to understand better not only the condition of the heart, but that of the patient also; in other words, they add to our knowledge of diseases of the heart and some of the conditions that accompany them. In passing let me say that there are a number of other diseases or conditions that may bring about changes in the thoracic cavity, the information of which obtained by means of the fluorescope may enable us to form a much better estimate of the patient's condition than would otherwise be possible.

I should be glad to take up examinations of the heart more fully, were it not that the importance of the subject demands more space than is now at my disposal.

In emphysema the lungs are unusually clear and their volume is increased. The heart is seen in the fluorescope more clearly than normal, although by percussion the outline cannot be determined. The diaphragm is seen to be lower than normal, and the excursion which it performs between deep inspiration and expiration to be less than normal. The heart also may lie lower than in health, and in the later stages in a more vertical direction. The lower position and the more limited excursion of the diaphragm

give a means of making a diagnosis of this condition probably earlier than has hitherto been possible, or in some cases the lack of these signs enables us to exclude it. Case B. F. suggests that there was no emphysema, although this was the diagnosis made from physical signs.

1. G. P., 55 years. Diagnosis: Pleurisy with chronic bronchitis; subject to asthmatic attacks and cough for years; caught cold two weeks before entrance to hospital. Physical examination: Severe cough with

FIG. 10. — Emphysema. Diaphragm lines lower and nearer together than normal. Dotted line indicates cardiac area by percussion. Broken line under inner end of left clavicle shows arch of aorta.

pain in left chest, with marked dyspnoea; lungs hyper-resonant throughout; respiration everywhere harsh, with many râles, fine, squeaking, sibilant, and coarse; expiration somewhat prolonged; friction rub in left axilla below fifth rib; respiration slightly diminished; heart negative; outline not found by percussion; no apex beat.

Examination with fluorescope: Diaphragm lower down in the chest than normal and the excursion 1¼ inches only. Outline of heart shown distinctly. The position and limited excursion of the diaphragm and the fact that the outline of the heart could not be obtained by percussion indicate emphysema.

2. G. J., 33 years. Emphysema and aortic regurgitation. Heart: dulness from left sternal border to just inside nipple line. Good resonance throughout the lungs; sibilant and sonorous râles.

Examination with fluorescope: The full line (see Fig. 10) indicates

a part of the cardiac area as seen in the fluorescope, the Crookes tube being 20 inches distant therefrom; the dotted line, the cardiac area as found by percussion. A comparison of these two lines shows that the fluorescope revealed more in regard to the size and position of the heart than was obtained by percussion.

3. M. A. J. Emphysema. Lungs hyper-resonant over all on percussion. Inspiration and expiration prolonged. Fine and coarse bubbling râles. Heart's area obscured by hyper-resonance of chest.

Examination with fluorescope: The diaphragm on both sides reaches the highest point at the sixth rib in the mammary line. Heart lower down in the chest than normal, but clearly seen; left border ¾ inch inside mammary line; right border 1¼ inches to right of sternum on level with nipple. Apex in fifth space.

4. B. F. Diagnosis: Emphysema with asthma. Examination with fluorescope: Diaphragm moved on the right side two and one-half inches, and on the left side three inches. This excursion of the diaphragm being normal suggests that there is no emphysema present.

In pneumo-thorax, hydro-thorax, and oedema of the lungs the fluorescope is of service; some partial oedema of the lungs is, I am inclined to believe, a more frequent condition than I had supposed. On first examining a patient of this latter class, his condition being unknown, I was surprised to find how difficult was the passage of the rays. I was at a loss when I found the picture of the patient's thorax in the fluorescope was unusually dark, and supposed something was wrong with my Crookes tube, but after trying another I realized that the patient's chest was denser than normal; the tube was not in fault. I give the following cases to illustrate the aid the fluorescope renders in oedema of the lungs; the fluorescope showed this condition when it was not made out by physical signs:

C. E., 47 years. Diagnosis: Chronic diffuse nephritis and cardiac. Three months previous to entrance to hospital patient complained of increased dyspnoea, fluttering of heart, and faintness; later, feet swelled in morning. Physical examination on entrance: atheromatous arteries; heart extended from one and one-half inches to right of median line to eight inches to left of line; apex beat in eighth space; no murmurs. Lungs: Dull in both backs below angle of scapula; over these areas breathing is diminished and accompanied by numerous fine râles. Ten days after entrance, feels less well and complains of dyspnoea. Eleventh day after entrance, Roentgen ray was tried on patient, but was not thrown through the chest, and the cause was thought, by Dr. Williams, to be

marked oedema of the lungs, but examination shows only a few moist râles at bases. Heart: At apex a rough systolic murmur is heard. Nineteenth day after entrance, eight days later, patient suffers a great deal from dyspnoea, sits up in bed nearly all the time, night and day. Pulse on twentieth day very weak; marked cyanosis; dyspnoea; death at 3.30 P.M.

Examination with fluorescope, eleventh day after entrance: First and second ribs can be fairly well made out on both sides. No outline of any ribs except the upper ones can be distinguished; lungs below the third rib are much darker than normal; no outline of diaphragm on either side to be seen; heart not seen. This examination, in connection with the physical signs, indicates oedema of the lungs, with, perhaps, some hydro-thorax.

C. J. J. Diagnosis: Chronic diffuse nephritis; cardiac dilatation. Dyspnoea on exertion; swelling of the feet; orthopnoea. Lungs: No dulness; moist râles heard over both bases, front and back; bronchitis and dyspnoea; improved under treatment.

Examinations with fluorescope: Ribs seen, but less distinctly than is normal; outlines of diaphragm and heart not sharply defined; heart considerably enlarged to the left. This examination, together with physical signs, indicates oedema of the lungs sufficient to increase their density and make the outline of the ribs and neighboring organs ill-defined.

It will prove instructive to study by means of the fluorescope cases of dyspnoea on exertion, and note the amount of congestion or oedema of the lungs accompanying them.

In some cases of bronchitis the lungs appear less bright in the fluorescope than in health, but in others this is not the case.

It not infrequently happens that the physician or patient fears the latter has some serious or obscure disease of the chest. In such cases, of the various methods of examining the lungs there is no one which gives such good evidence that they are free from serious disease as the examination with the fluorescope.

The foregoing observations and cases show that by X-ray examinations of the chest we gain assistance in recognizing a density greater than normal, in tuberculosis, pneumonia, infarction, oedema, congestion of the lungs, in aneurism, and in new growths; they likewise assist us to recognize fluid in the pericardial and pleural sacs. The distribution, location, and amount of this increase in density which the

fluorescope shows assist us in some cases to differentiate these diseases and conditions. Diminution of the normal density, which is the result of emphysema and pneumothorax, is indicated by the position and movement of the diaphragm; a certain curve of the diaphragm is characteristic of this latter condition. The excursion and position of the diaphragm are of assistance in determining the condition of a lung or lungs in tuberculosis, pneumonia, and other diseases. As is the case with all other observations on which a diagnosis is founded, the conditions which are revealed by the fluorescope are only to be properly interpreted after experience in making X-ray examinations has enabled the physician to give these observations their due weight.

I have already referred in a previous article to the experiments made at the Massachusetts Institute of Technology on the action of the X-rays upon several forms of bacilli. The rays in these experiments had no effect on the bacilli.

I shall preface the following surgical cases by a few brief suggestions only, which may be of assistance to those who are beginning to use the X-rays in surgical cases.

The character of the radiograph depends, to a considerable extent, upon the length of the exposure. Too long an exposure will show an excellent picture of the bones, but not the soft parts; a shorter exposure may give bones, muscle, fat, etc.

A more satisfactory examination of the leg and forearm can be made with the fluorescope than of the thigh, for example, because in the former the bones lying closer to the surface are nearer to the fluorescope, and therefore their outlines are more sharply defined than those of the femur or hip-joint. These latter are better seen with a strong light at some distance from the patient. In passing it may be of interest to note that in the examination of the hip-joint it is an advantage to have the patient lying on his face.

Fractures with displacement of the bone can be readily made out by means of the fluorescope; when, however, there is fracture with only slight change in the outline it is

not readily detected by this means, but may be found more certainly by a radiograph. The fluorescope sometimes gives a better appreciation of the conditions in fractures with sufficient displacement, because by turning the part it may be seen from more than one side. The fluorescope also enables the practitioner to use both eyes and hands: that is, the part may be examined by the hand while observing it through the fluorescope. This enables him to determine, for instance, that a given induration is not bony, although it feels as if it were.

In examining the extremities it is well to compare the diseased with the healthy one; for example, the outlines of tuberculous joints, and especially the ends of the bones near them, are obscured instead of being sharp in outline: the diseased bones seem larger, but not so dark as the healthy bone. There appears to be less of inorganic salts in the diseased than in the normal bones, and more inorganic salts in the tissues surrounding the diseased bones than in the corresponding parts on the normal side. Whenever possible it is advisable to place both the healthy and the affected extremity side by side under a large fluorescope.

A radiograph of a cancer of the breast, taken after removal, showed the diseased portions were more resistant to the rays than the healthy tissues.

NEEDLES, BULLETS, AND GLASS.

1. Piece of needle in ulnar side of hand.

Fluorescope and radiograph showed needle, which was removed by surgeon.

2. Two bullet wounds, one about 2 inches posterior to large trochanter of right femur, second over last lumbar vertebra, about 1 inch to left of median line.

By fluorescope, one bullet located on inner side of right thigh, 2 inches below pubes; removed by surgeon. Second, just above the left sacro-iliac synchondrosis. [Allowed to remain.]

3. Bullet wound of right shoulder.

Bullet located by fluorescope and removed by surgeon.

4. Piece of needle in left knee.

Located by fluorescope over inner tuberosity of tibia; removed by surgeon.

5. Piece of needle in hand four weeks ago.
Located by fluorescope and radiograph; removed by surgeon.

FIG. 11. — Radiograph of hand, showing that the enlargement of the ends of fingers was not due to changes in the bone.

6. Bullet in thigh.
Located by fluorescope; removed by surgeon. Had been searched for unsuccessfully outside the hospital.

7. Piece of needle in thenar region.
Located by fluorescope; removed by surgeon.

8. Piece of needle in toe.
Seen in fluorescope; not found by surgeon.

9. Bullet wound in groin.
Fluorescope located bullet in thigh; removed by surgeon. Previous unsuccessful search before entrance to hospital.

FIG. 12.—Epiphyses of femur and tibia.

10. Small wound in calf of right leg, probably from piece of cartridge exploded on car track.
Small piece of metal (copper) located in leg; removed by surgeon.

11. Piece of needle in foot.
Located by fluorescope; removed by surgeon.

12. Bullet in left thigh.
Located by fluorescope and radiograph; removed by surgeon.

13. Piece of needle in right hand.
Located by fluorescope; removed by surgeon.

14. Small bit of glass in finger.

Fluorescope showed nothing; radiograph showed triangular piece of glass about $\frac{1}{8}$ inch the longest way. See Fig. 18.

15. Bullet wound of back.

Shot in left back over scapula. Bullet located by fluorescope and found in right back under scapula.

With the fluorescope held against the back, the patient lying on his face, considerable movement of the Crookes tube from side to side gave very slight movement of shadow of bullet, thus showing that it was near the surface of the back.

Removed by surgeon.

16. Congenital malformation of toes.

Radiographed.

17. Necrosis of ileum.

Radiograph showed roughened outline of ileum.

18. Necrosis of tibia.

Fluorescope shows lighter area in tibia about 3 inches long, beginning about 1 inch above ankle, at the upper end of this a light area $\frac{3}{4}$ inch in diameter. Radiograph also shows the same. Appearances confirmed at operation.

19. Tubercular knee.

Fluorescope: outline of left knee-joint not defined. Head of tibia larger. Radiograph shows the same. Appearances confirmed at operation.

20. Osteo-sarcoma of humerus.

Fluorescope and radiograph show distinctly great enlargement of humerus and shaggy outline. See Fig. 16.

21. Osteo-myelitis of right humerus.

Fluorescope shows whole humerus thickened and roughened, head of bone involved.

22. Tuberculosis of femur.

Fluorescope and radiograph show thickened femur.

23. Fracture of patella after wire suture.

Radiographed.

24. Fracture one year old of both bones of leg.

Sinus into which crayons of iodoform had been inserted. Fluorescope shows fracture and also iodoform which is as well marked as a piece of lead.

Radiographed. See Fig. 14.

25. Tuberculous knee. Left knee considerably swollen, quite uniformly, surface moderately tense, knee held at moderate flexion.

By fluorescope: no outline of knee-joint seen; head of tibia and fibula

Fig. 13. — Old fracture of radius.

and patella not seen; all of these clearly seen in other knee. The radiograph gave the same result. The appearances suggested the presence around the joint of some deposit through which the rays passed less readily than through normal tissues.

26. Fracture of tibia in stout woman.

Seen clearly in fluorescope; seemed in perfect position when examined antero-posteriorly, but the lateral view showed some overlapping.

FIG. 14. — Fracture of both bones of leg which has been dressed with iodoform. This latter obscures the fracture of the tibia. The dark foreign bodies resembling pieces of metal are pieces of iodoform. This radiograph was taken with bromide paper which was then coated with oil, and silver prints were made therefrom.

27. Necrosis of hand.

Fluorescope shows about the third metatarso-phalangeal joint enlargement and bending of first phalanx.

28. Old injury to elbow.

Radiographed.

29. Necrosis of feet after frost-bite.

Radiographed.

30. Exostosis of inferior surface and distal end of third and fourth metatarsal bones about the size of a large pea Removed by operation. This enlargement was not seen in the fluorescope; but the patient was a child five years old, and therefore it was less marked than in an adult.

No radiograph taken.

Fig. 15.— Rickets in colored child three years old.

31. Hard, perhaps bony, tumor in popliteal space, marked tenderness to slight pressure; hard swelling, not pulsating.

Fluoroscope showed bones and knee-joint normal; examining finger when touching hard and tender point was seen to be at least two inches from bone.

[At operation proved to be vascular tumor about the size of a walnut.]

32. Fracture forearm two years before.
Fluoroscope and radiograph showed fracture clearly.

33. Congenital deformity of hand.
Radiograph showed clearly the malformation of bones.

34. Osteo-sarcoma of right femur.
Suppurative periostitis of left fibula.
Fluoroscope shows right femur clearly defined, no enlargement Left fibula thickened and not sharp in outline.

35. Fracture of vertebrae.
Radiograph unsuccessful, as plate proved to be a poor one. [Did not fix after development.]

FRACTURE SUSPECTED, BUT NOT FOUND BY THE X-RAY EXAMINATION.

36. Fracture of the radius three inches above carpus, found to be perfectly straight and normal in fluoroscope.

37. Fracture of ulna nine weeks old.
Fluoroscope showed dislocation of carpal end of radius.

38. Injury of foot; question of fracture of external malleolus or dislocation of bones of foot.
Fluoroscope showed nothing abnormal.

39. Child eight years old swallowed a silver twenty-five-cent piece, some years previously; some bronchial irritations since.
Radiograph of whole of upper half of body showed a perfectly normal thorax, and no coin present.

40. Fracture of os calcis. Tenderness and swelling below external malleolus.
Fluoroscope did not show any fracture.

41. Needle in palm of hand on previous day.
No needle found by fluoroscope or radiograph.

42. Needle in foot two years previously.
Fluoroscope and radiograph showed no needle.

43. Suspected injury to elbow-joint.
No fracture found by fluoroscope.

44. Colles fracture.
No evidence of fracture in fluoroscope.

FIG. 16.— Osteo-sarcoma of the humerus.

45. Recent fracture close to base of first metacarpal, crepitus distinct.

No evidence of fracture found in fluorescope.

46. Fracture of os calcis.

I compared this heel bone with the normal foot under the fluorescope and as a further means of testing the condition of the bone I tried to

FIG. 17. — Bullet in the tibia; just below the bullet small dark spots are seen, which are bits of lead scraped off the bullet in its passage through the bone. This indicates that the bullet was fired from a point below the level of the knee. (The patient dropped his revolver on to the floor, when it went off.) Evidence of this sort might prove serviceable in a medico-legal case.

move the supposed fractured os calcis, while at the same time looking at it with the fluoreseope. No fracture was detected.

47. Fracture of metatarsus.
Intense pain, tenderness, arch of foot seems flattened out.
Radiograph showed nothing abnormal.

48. Baby said to have needle in side of abdomen.
No needle seen in fluorescope.

FIG. 18. — Small piece of glass in inner side of little finger.

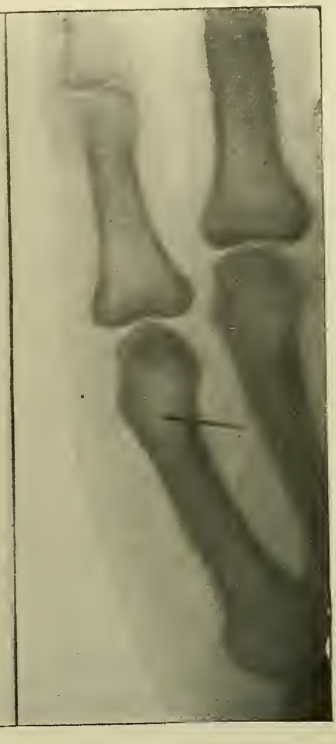

FIG. 19. — Needle in hand.

49. Sprain of ankle (?)
Fluorescope shows no deformity of ankle compared with uninjured one.

50. Fracture of cervical vertebrae.
Four cervical vertebrae seen in fluorescope; nothing abnormal made out.

51. Fractures of condyles of humerus; question of good position of parts; considerable swelling.
Fluorescope shows position at elbow good.

52. Compound fracture of femur; long suppuration; extreme sensitiveness of femur for several weeks; considerable thickening of femur; question of osteo-myelitis.

Fluorescope shows outline of left femur clearly defined; thickening felt by finger while looking through fluorescope evidently not bony.

53. Question of foreign body in finger.
Nothing shown by radiograph.

54. Question of piece of needle in finger.
Nothing shown by radiograph.

55. Question of injury to bones of hand.
Fluorescope shows no bony injury.

56. Question of renal calculus.
Nothing seen in radiograph.

57. Question of needle in thumb.
Fluorescope and radiograph show no needle in thumb.

58. Question of fracture of shoulder.
No injury seen by fluorescope.

No harmful effects have been received in any way by the patients, more than two hundred and fifty in number, whom I have thus far examined by the X-rays at this hospital, and there need not be the slighest anxiety on the part of the patient if the examinations are made by some one who has had experience and has suitable apparatus. I have seen, however, several persons who have suffered a more or less severe inflammation of the skin, the nails also being sometimes involved, but they were all individuals whose occupation brought their hands into close proximity to the Crookes tube, or who, for purposes of testing its possibilities for harm, had exposed some part of the body to its action at a short distance for a considerable period. But there are simple ways of obviating these effects.

Interesting, not to say magical, as are the physical phenomena connected with the X-rays, we should not be led to assume for them an exaggerated importance in practical medicine. They do unquestionably afford us valuable aid, and through them an advance in our methods of examining patients is obtained. I have thus far found them of especial service in diseases of the chest.

I have had the privilege of studying the physics of the X-rays in the Rogers Laboratory of the Massachusetts Institute of Technology, and I am under obligation to Pro-

fessor Charles R. Cross and two of his assistants, Mr. C. L. Norton and Mr. R. R. Lawrence, for their coöperation. I also desire to express my appreciation of the active interest taken by the trustees of the Boston City Hospital in my work, and the kindness of my colleagues on the staff for affording me an opportunity of examining many of their patients.

SUMMARY.

Apparatus and methods described.

Respective uses of fluorescope and radiograph considered.

Causes of the difference in permeability which the tissues and organs of the body offer to the passage of the X-rays.

Calculi and instrument for radiographing them in the bladder.

Normal thorax described as seen in the fluorescope.

Importance of the position and movement of the diaphragm in estimating or excluding abnormal conditions of the lungs.

Uses of fluorescope in tuberculosis, pneumonia, pleurisy, aneurism, emphysema and oedema of the lungs considered and illustrative cases given:

The fluorescope gives us earlier evidence of disease in some cases of tuberculosis, and in pneumonia more accurate information, than can be obtained by the usual physical examination.

The fluorescope gives us the means of making an earlier diagnosis of certain cases of thoracic aneurism than any other method.

The fluorescope enables us to recognize or exclude emphysema.

The fluorescope assists us to recognize oedema of the lungs, pneumo-thorax and hydro-thorax.

The fluorescope shows a displacement of the heart in pleurisy, which is sometimes not recognized by other means.

The fluorescope assists in the recognition of fluid in the pleural cavity.

The fluorescope enables us to outline the heart more accurately and more completely than has hitherto been possible, and assists us to recognize certain changes in the heart.

Examples of surgical uses.

VI.

THE SERUM TEST FOR TYPHOID FEVER.

By George B. Shattuck, A.M., M.D

The cases here summed up and analyzed, in which Widal's serum test for typhoid fever was applied, were all patients in the City Hospital. Seventy-three of these cases are taken from the third medical service, thirty-six from the first, and thirty-six from the second. The tests were made in the pathological laboratory under the supervision of Dr. T. Leary, of the pathological department, by the house officers of the three medical services, to whom much credit is due for zeal and intelligent industry in a task outside of their regular work. The clinical statements are necessarily subject to the unavoidable peculiarities of hospital practice, though every effort has been made to have them as accurate as possible. The date of the beginning of typhoid fever, for instance, has been assumed as the time to which the patient refers the first constitutional symptoms. The patients are not always intelligent, even when they desire to be correct. This throws unavoidable doubt upon the day of the disease upon which tests were made, and affects the value of conclusions drawn. On the other hand, after entrance to the hospital the patients were always under careful supervision, and both the number and variety of cases presented are considerable.

In some of the cases a larger number of tests at different periods of the disease might advantageously have been made had there been a larger force and more time at our disposal. All the tests were made with liquid blood. The test with dried blood was not tried. Only incidentally can we claim to make a contribution to the questions of the proportion of serum to typhoid culture, of the early and late periods at

which the reaction may be obtained, of the existence of other blood serums giving the same reaction. The fate of the diazo reaction has been borne in mind, and that test has been noted in connection with a large percentage of these cases. A number of cases were rejected on account of defective records or defective tests. In the laboratory a longer maximum time limit, one hour, was allowed for the reaction than some observers would consider justifiable. Many of the reactions did occur in much less time, the character of the reaction was considered as well as the time within which it occurred, and the room culture reacts less promptly than the thermostat culture.

Of these 145 cases 125 may be set down as typhoid fever either straight or with complications; 19 were not typhoid; and one may perhaps be classed as doubtful, though reacting to the serum test.

TECHNIQUE.

Dr. Leary furnishes the following statement in regard to the laboratory technique:

The cultures used at the laboratory for the serum test for typhoid fever were obtained from several sources. Three were obtained from spleens of patients who had died of typhoid fever, and a fourth from fluid aspirated from a tumor mass which corresponded in position to the gall-bladder, from a patient who was suffering from that disease. Daughter cultures from these were used, without choice, during the early tests, but shortly afterward it was thought best, in order that the conditions surrounding the tests should be as exactly alike as possible, that the cultures used should all come from the same sources. One of the spleen cultures was selected and its progeny has furnished all of the preparations since used. Up to January 1 the tests were made with twenty-four-hour bouillon cultures grown at a thermostat temperature. At that time some tests were made with cultures grown at the room temperature, and the results were so satisfactory that all tests since that time have been made with room cultures. In the room cultures the organisms while fewer in number are larger and more motile, and the reactions, while perhaps a trifle slower, are

so absolute that little difficulty occurs in making a diagnosis. In the thermostat cultures there often is a small sediment made up of dead organisms which if shaken up into the fluid may interfere with a diagnosis. This sediment is much less likely to occur in connection with room cultures. Room cultures again can be used for the test when much older than thermostat cultures, the growth being more gradual and the organisms being hardier.

The technique as used is that commonly practised. Blood is obtained from the ear of a patient, the skin being first washed with alcohol, and a single deep puncture made with a glover's three-cornered needle. The blood is collected in a piece of glass tubing which has been sealed at one end. The open end is then plugged with cotton. The blood is brought to the laboratory and a clot allowed to form, which takes usually three to five minutes. A drop of the nearly clear serum is then placed on a glass slide, and surrounded by ten drops of typhoid-bouillon, the drop measure being a small loop on a platinum needle. The serum and bouillon are then thoroughly mixed and covered with a clean cover glass, care being taken to exclude all air.

A positive diagnosis is made if before an hour has elapsed the bacilli in good part have lost their motility and have grouped themselves, not lying together in close masses or in parallel bundles, but gathered loosely as logs may be thrown together in the eddy of a river. Dead bacilli in the cultures tend to clump closely in more or less parallel masses.

An hour was arbitrarily made the limit of time for the test, since it was found that within that time satisfactory clumping would occur if it was going to occur at all. A shorter limit would have placed many tests in the doubtful column, which were satisfactory at or near the end of the limit of time, and which were oftentimes repeated with success on cases of undoubted typhoid.

In the early experiments which were made here, too much, perhaps, was demanded of the test. It was expected that, in a satisfactory test, practically all of the bacilli should be motionless and grouped in masses which should nearly cover the field of a Leitz $\frac{1}{12}$ oil objective No. 3 eye-piece. In the later tests this has not been expected. It was thought

sufficient if groups of twenty to forty organisms might be found perhaps twice in five fields, with some organisms still showing motility.

Tests in which the number of blood corpuscles on the slide was too great, or where much air was present in globules, were ruled out and repeated, as were tests in which any doubt existed about the correctness of the technique or about the character of the reaction.

ANALYSIS OF THE RESULT OF THE TEST IN 116 CASES WITH A CLINICAL DIAGNOSIS OF TYPHOID.

Reaction before the 10th day:

"	6th day	1
"	7th "	4
"	8th "	6
"	9th "	5
"	between 10th and 15th day	23
"	" 15th and 20th "	16
"	" 20th and 30th "	32
"	" 30th and 40th "	13
"	" 40th and 50th "	11
"	" 50th and 60th "	5
"	" 60th and 70th "	2
"	" 70th and 80th "	2
"	" 80th and 90th "	0
"	" 90th and 100th day	0

" 100th day and over: 1, 100th day; 1, 110th day; 1, 121st day; 1, 122d day.

" 1 on the 39th day and 122d day, relapse, phthisis.

" 1 on the 110th day, relapse; 1 on the 100th day, post-typhoidal neuritis.

" 1 on the 121st day, phlebitis.

No reaction in 1 case.

No reaction in 2 cases; one test only, and the 12th day; and one test only, on the 82d day.

" " 1 case on 26th day; reaction, 27th day.

" " 1 " " 15th " " 16th day.

" " 1 " " 16th and 18th days; reaction, 59th day.

No reaction in 1 case on 7th day; reaction, 9th day.
" " 1 " " 18th day; reaction, 45th day.
Doubtful reaction in 1 case on 10th day; reaction, 13th day.
" " 1 case on 20th day; reaction, 26th and 28th days.

ANALYSIS OF THE RESULTS OF THE SERUM TEST IN 11 CASES WITH A DOUBTFUL DIAGNOSIS.

Of these doubtful cases 4 gave no reaction to the serum test at any period. One of these was, without doubt in view of its whole course, a case of meningitis.

Another is a particularly instructive case. No antemortem diagnosis was made in the hospital. The patient entered on the 124th day of his illness, as "after typhoid." His doctor reported that the patient had had rose spots, enlarged spleen, and typical course of typhoid fever. At entrance great emaciation with bed sores; no fever. No reaction to two tests. Death. Autopsy. Old malignant endocarditis.

The third case gave a negative physical examination, very vague symptoms and course; slight temperature, soon becoming normal. There was no diazo, and no reaction to the serum test on the 15th day. The diagnosis of typhoid was entertained, but not positively made. The patient was discharged well on the 29th day.

The fourth gave a negative physical examination, and had very vague clinical symptoms and course. On account of a chill, plasmodia were sought for, but not found. The diazo reaction was absent. A serum test was made on the 6th day and was negative. Unfortunately there is no record of its having been repeated. The diagnosis of typhoid was considered, but remained in doubt. The patient was discharged well on the 23d day.

In 5 of these cases the serum test gave a positive result, and was of material service in determining a doubtful diagnosis.

In the first of these cases the physical examination was negative; symptoms were absent, but there was some temperature. It was said that there had been cases of typhoid

fever in the neighborhood of the patient's home. The serum test gave a good reaction on the 22d, 23d, and 24th days.

The second case was that of a professional man, a private patient, 52 years of age; a rather steady drinker. Six weeks before entrance, whilst in another city on important business and subject to some strain from work and anxiety, he suddenly became mentally confused for a short time, though not entirely losing consciousness. From this he recovered entirely. Two weeks later at home he had another similar attack with incomplete recovery mentally. He was slow in expression and miscalled words. A week before entrance the left leg was noticed to be swollen and painful on pressure. There were blood, albumen, and casts in the urine. The attending physician, an excellent practitioner of large experience with typhoid fever, had diagnosticated serious renal disease and given a grave prognosis.

He entered the hospital 30 days from the beginning of the illness, with weakness, loss of appetite, and mental confusion. The edge of the spleen was felt, otherwise the physical examination was negative. The temperature might have been that of the end of typhoid. There was no diazo. The clinical diagnosis was reserved. The serum test gave a prompt reaction, and the patient made a good recovery as from typhoid fever.

The third case was considered as probably meningitis, and the symptoms pointed strongly in that direction. Two separate serum tests, at a period of the disease which could not be specified, gave positive reactions. The patient recovered. This was probably a typhoid with meningitis.

The fourth case presented a normal temperature two days after entrance. History suggested, as a possible diagnosis, the end of an ambulatory typhoid of six weeks' duration. The serum test gave a positive reaction on the forty-second day.

The fifth case was considered as perhaps one of uræmia. History and symptoms vague. There was œdema, delirium, slow pulse, enlarged spleen, strabismus, nystagmus, retraction of the neck, twitchings. There were prompt reactions to the serum test on the sixteenth and nineteenth days. Death. No autopsy.

In two doubtful cases, the serum test gave both a positive and negative reaction on different days. In one of these cases gastritis was suggested as a provisional diagnosis. The physical examination was negative, the symptoms and course very vague. On the seventh day there was a positive reaction to the serum test, and on the eleventh day no reaction. Herpes appeared on both lips on the eighth day. No diazo. This patient was discharged well on the fifteenth day. In the other case the history was rather typhoidal, the symptoms and course were very vague. There was no reaction to the serum test on the fifteenth and eighteenth days and a good reaction on the twenty-second day.

ANALYSIS OF THE RESULT OF THE SERUM TEST IN 18 CASES WITH A CLINICAL DIAGNOSIS OTHER THAN TYPHOID FEVER.

There was no reaction in 15 of the above cases, of which 2 were pneumonia, 2 pleurisy, 4 meningitis, 3 "febricula," 1 was phthisis, 1 acute miliary tuberculosis, 1 appendicitis, 1 influenza.

There was a reaction in 3 of the above cases, of which 1 was pneumonia, 1 was thought to be acute miliary tuberculosis, 1 was exophthalmic goître. In all 3 of these cases the typhoid reaction was justified, and the test made the diagnosis. In the case of pneumonia the test was made on the 15th day of the illness; the patient died on the 22d day; there was no autopsy, but there is little doubt that there was both pneumonia and typhoid fever.

In the case of exophthalmic goître, the symptoms were masked and confusing, and typhoid was not at first suspected. Three distinct tests were made not earlier than the 20th day; all gave a positive reaction. The patient eventually died of pneumonia on the 43d day after entrance to the hospital, and the autopsy showed small but characteristic typhoid ulcers nearly healed.

In the case diagnosticated as acute miliary tuberculosis the symptoms and course were perplexing, but on the whole justified such a diagnosis and an unfavorable prognosis was given. The patient later developed diphtheria,

was transferred to the diphtheria department, and whilst there as a convalescent, on the 69th day the serum test, which was not being practised when he first entered the hospital, was made, and gave a prompt and positive reaction. This case recovered.

THE TEST WITH NEGRO BLOOD.

The query having arisen[1] whether serum from the blood of the negro was more prone than that from the white to produce the reaction even in the absence of typhoid fever, tests were made by Dr. Leary, at my request, with serum from thirteen colored patients, of various admixtures, but the majority negroes, in the hospital, with clinical diagnoses other than typhoid. In eight of these there was no reaction. In three there were reactions more or less satisfactory with thermostat cultures, but none with room cultures. In two there were good reactions both with "stat" cultures and with room cultures. Of these two, one was a black negress, the other a mulatto born in Africa. They were both surgical patients. In each case the *status praesens* and the history were carefully gone over. They certainly have not had typhoid fever since entering the hospital. Typhoid cannot be excluded from the histories of the previous six months, but the symptoms and conditions reported can be better explained by other causes, and without the result of the serum test typhoid would certainly not have been considered. These cases have not been included in the 145 previously analyzed.

THE DIAZO REACTION.

This reaction was sought for in the urine and the result recorded in 89 cases out of the 125 cases of typhoid fever; it was found in 42 cases, and not found in 47 cases. In 1 case the diazo reaction curiously though rationally enough was present on the 15th day when the serum test was absent, and absent on the 59th day, when the serum test was present.

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[1] J. W. Brannan, M.D., "New York Medical Journal," March 27, 1897.

CONCLUSIONS.

1. The serum reaction may be obtained towards the end of the first week of typhoid fever, but is both more pronounced and more usual later in the course of the disease.

2. It may be present without relapse at the end of the fourth month.

3. It may be absent one day and present the next.

4. Of 125 cases of typhoid fever the reaction was absent in only one case. In two cases it failed, but there was in each only one test, in one case on the twelfth and in the other on the eighty-second day.

5. In 19 cases of other diseases clearly uncomplicated by typhoid there was no reaction.

6. In one case, where the diagnosis must remain doubtful, although typhoid cannot be positively excluded, there was a reaction.

7. In a number of difficult and perplexing cases the serum test was of distinct service in establishing or correcting the diagnosis.

8. This test will probably prove itself a useful aid to clinical diagnosis, and especially in hospital practice.

VII.

CASES OF MULTIPLE SARCOMA.

By Charles F. Withington, M.D.

Sarcoma is the most malignant of all neoplasms. The present article does not deal with it from the point of view of histology or pathology, but seeks to illustrate the clinical facts bearing upon its history and the direction and mode of its growth. I have collected from the hospital records eight cases, in the first three of which autopsies were made, and have added one private case with autopsy. These cases show the usual method of metastasis; namely, by the blood-vessels, as distinguished from that of carcinoma, which is by the lymphatics. In the first seven cases the skin was extensively involved, making a conspicuous clinical picture, which we are able in some instances to illustrate by photographs. In none of the cases, however, had we to do with the primary multiple sarcoma cutis of the dermatologist. The range of organs involved in secondary growths will be seen to have been very great.

Case I. — J. H. L., widower, aged 70, flour merchant, a native of Maine. Both parents lived to old age. No history of tumor in any member of the family. The patient has had excellent health except for inflammatory rheumatism several times, malaria, and an attack of jaundice some years ago.

He entered the third medical service under the care of the writer, April 27, 1896. For the previous six or seven months he had been losing weight, strength, and appetite. Six months ago he first noticed a number of small black tumors on the surface of the body. These have increased in number and size since then. It was further learned that he has had for twenty or thirty years a tumor on the pos-

terior aspect of the right shoulder. This growth was non-pigmented and painless, and he was told by a physician whom he consulted that there was no need for its removal.

His further symptoms were gastric pain, vomiting, occasionally of a little blood, cough, with occasional bloody expectoration; for two or three weeks some œdema of the feet and legs. The increasing weakness made him take to his bed April 18. A decided mental weakness has shown itself during this time of bodily failure, and while being questioned

Fig. 1.

he would sometimes drop off to sleep for a minute or so, then rouse and ask what had been said.

The entire body was covered with small nodular masses, estimated to number 400 or 500 at least. They varied in diameter from $\frac{1}{10}$ to $\frac{1}{4}$ of an inch. They were dark-brown in color. Most were elevated above the skin; some were subcutaneous. They were most numerous about the breast and back (see photographs Nos. 1 and 2), but were also

scattered over both legs, arms, and hands. A few were on the head and face. On the right side of the neck, posteriorly (as shown very well by photograph No. 2), was a nodule much larger than any of the others, say one

Fig. 2.

and one-half inch in diameter. This was the original tumor, of twenty or thirty years' duration. It was red, somewhat hard, easily movable, and not especially tender.

The new growths all over the body itched considerably. There was marked anasarca, with some fluid in the perito-

neal cavity and in both pleuræ (to the angles of the scapulæ). The heart was of normal area, sounds feeble, no murmurs. Urine, S.G. 1018; trace of albumen; sediment, a large deposit of urates; few abnormal blood globules; occasional leucocyte and finely granular cast. The liver was evidently much enlarged by neoplasms. The dulness extended from the fourth interspace to 2½ inches below the costal border, the breadth of the dulness being 9½ inches. The edge was easily felt, rough, nodular, and very hard; the left lobe was also distinctly felt.

There was rapid failure, mentally and physically, and the patient died May 6, the temperature (which had been subnormal) rising in the last few days with signs of consolidation in the right lung.

The autopsy was made May 7. Its most important features were the following: The heart weighed 320 gm. The pericardium was everywhere closely adherent to the heart, but could with a little difficulty be stripped from it. The fat tissue surrounding the pericardium was studded with innumerable small whitish and grayish, rarely blackish, tumors, size of a pin-head to a pea. On section of the heart, the inner wall of the right auricle was found studded with dozens of small whitish and grayish tumors of from 1 to 3 mm. in diameter, somewhat elevated; others were just below the pericardium. In the right ventricle were a number of similar tumors, but not so many, in the wall and in the papillary muscles. In the left auricle were none; in the left ventricle were half a dozen, partly in the wall and partly in the papillary muscles.

In the lungs were large numbers of tumors, from pin-head size up to 1 cm. in diameter, beneath the pleura, and in the substance of the lung tissue. They were rather more numerous on the left side. In the right pulmonary artery were several emboli in the smaller branches. In the lower part of the right upper lobe were two infarctions about 4 cm. in diameter. The middle lobe was solidified and covered with a fibrinous exudation.

There were infarctions of the spleen and both kidneys. In the right kidney was a tumor the size of a pea. The fat capsule surrounding both kidneys was everywhere studded

with inflammatory small gray and white tumor masses. The bladder contained three small projecting masses the size of a pea.

In both testicles were several small nodules, grayish-white in color.

The liver weighed 3850 gm., was uniformly enlarged, and studded everywhere with whitish, grayish, and, in places, blackish nodules, slightly lobulated, even with the surface or slightly depressed in the centres, of size from a pin-head to 1 or 2 cm. They were about equally numerous throughout the liver substance. The gall-bladder was distended, its inner surface covered with numerous irregular papillary greenish-gray masses, some of them more than 1 cm. in diameter.

The pancreas was enlarged and studded with tumors. On section it looked as if nearly the whole of the pancreatic tissue had been transformed into tumor structure.

Similar growths were found beneath the peritoneum, the stomach, and in the fat tissue of omentum and mesentery.

The lower portion of the inferior vena cava was nearly occluded by a thrombus 6 cm. long, reddish-gray in color, with roughened surface, the upper end irregular and jagged, and the lower conical and attached to the point of division of the inferior cava into the common iliac veins. (This thrombus was evidently the cause of the œdema of the legs.)

The brain, which weighed 1240 gm., showed marked œdema of the pia. There was slight chronic lepto-meningitis. Everywhere in the cortex of the brain were fairly numerous minute grayish tumor masses rarely exceeding 2 millimetres in diameter. They were most numerous in the apices of the temporal lobes. None were found in the cerebellum or medulla. On section, few were found in the white matter except in the basilar ganglia.

The examination of the original tumor of the neck, which was on removal 4½ cm. in diameter, showed it to be on section grayish and white, mottled, with here and there almost blackish areas (melano-sarcoma).

In this case there was no doubt that the original tumor of 20 or 30 years' standing eventually took on a malignant

character, and was the source from whence the wide-spread metastasis took place. The anatomical findings are on the whole very similar to those in Case II. In the present case the cerebral distribution was largely cortical and doubtless occasioned the loss of mental power. In the last few days of his life the patient insisted on getting out of bed and wandering about the ward, was markedly demented, and finally lost all power of recognizing even his own children.

Case II. — C. M., aged 61, widower, shoemaker, born in New Hampshire; entered Nov. 30, 1894, in the service of Dr. Mason. A hard-working man of temperate habits; family history negative.

About three months before entrance, patient noticed a small bunch on the left side of the forehead. Soon after, similar bunches began to appear on the breast. Their advent was accompanied by a sensation of heat and of stinging as by a bee. For the last two months there have been marked symptoms of indigestion, with vertigo, headache, and especially shooting pains in the occipital region. He took to his bed three days ago.

The patient appeared well nourished, but over the entire body, including all the extremities, were many discrete nodular hard tumors in the subcutaneous tissues, averaging about the size of a large pea. These were especially numerous on the surface of the abdomen. A few here and there had caused pigmentation on the surface of the skin. Neither palpation nor percussion showed apparent involvement of any internal organs, except that the liver was enlarged to two inches below the rib margin, where its edge was distinctly felt. There was also tenderness over the epigastrium; physical examination otherwise negative.

His symptoms immediately after admission continued to be chiefly digestive. Epigastric distress, occasional vomiting, constipation, occipital headache persisted, and after a day or two his mental state was not quite so clear. He was increasingly feeble and slept poorly. His color was becoming pale.

An examination of the eyes, December 11, showed in the left retina many small recent hæmorrhages, and in the

right retina a very dark choroidal tumor the size of the optic nerve, just outside the macula.

A blood examination at this time showed nothing especially abnormal.

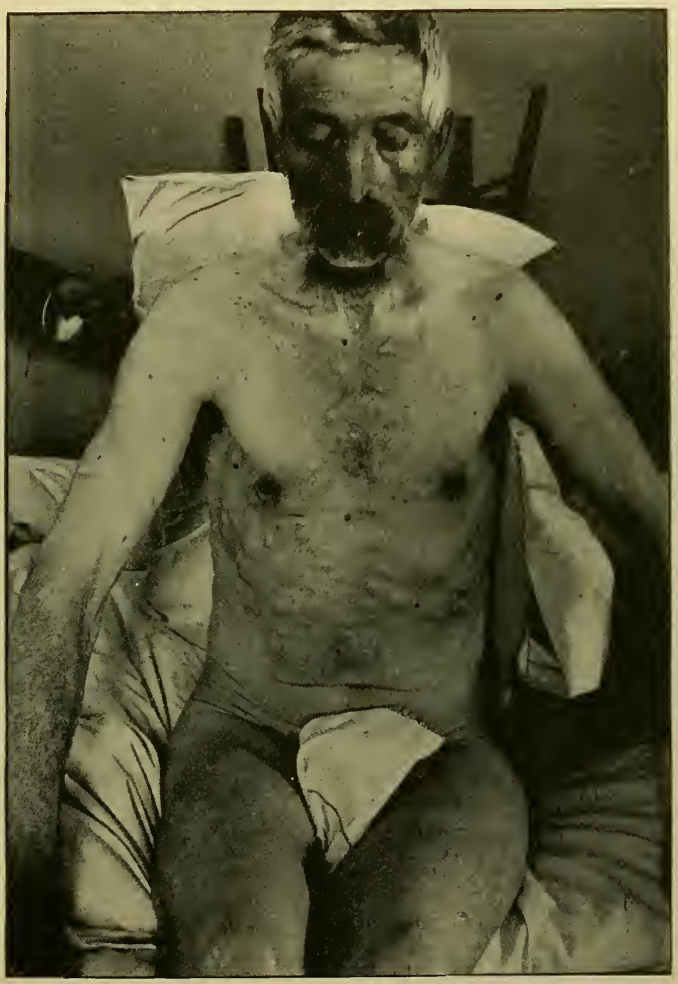


Fig. 3.

With increasing weakness hiccough appeared and a moderate diarrhœa. Meanwhile the subcutaneous tumors were greatly multiplying in number. Another blood examination, on December 23, showed a considerable increase in

the white corpuscles, the ratio being 1: 41.4. Reds, 4.188-000. A differential count of the whites showed

Small mononuclear	6.4%
Large mononuclear and transition forms . .	2.2%
Polynuclear neutrophiles	90.2%
Eosinophiles	1.2%

Moderate delirium with increasing stupor and apathy succeeded, and in the last day or two of his life the temper-

Fig. 4.

ature, which had been irregular, but only a little elevated, made a sudden rise to 103.5°, and the patient died of exhaustion, December 28.

Of the accompanying photographs Fig. 3 shows the appearance soon after admission, and Figs. 4 and 5 just before and just after death.

The autopsy, made by Dr. Mallory twelve hours after death, showed a broncho-pneumonia which was evidently the immediate cause of death, and revealed multiple sarcomata of skin, muscles, brain, heart, lungs, mediastinum, kidneys, bladder, penis, scrotum, œsophagus, stomach,

diaphragm, intestine, pancreas, thyroid, adrenals, peritoneum, omentum, and mesentery.

In the skin it was noted that besides the very numerous nodules over which the epidermis was slightly movable, there were a number of yellow and brown pigmented areas (the largest 8 mm. in diameter), beneath some of which there were nodules, beneath others none.

The condition of the cranium was of especial interest because of the situation of the original tumor, over the frontal bone. (This tumor, it will be remembered, dated

Fig. 5.

from only four months before death.) On removing the calvarium, on the left frontal region of the dura, corresponding to this original tumor outside the skull, was a nodule in the dura, which extended through the skull at this point and formed one continuous tumor with that beneath the skin. It was impossible for the pathologist to state whether the portion of the tumor outside or that inside of the skull was the original.

Meshes of the pia contained considerable fluid. Beneath the pia, over the convexities, were numerous gray and dark-red tumors, varying in size from a pin-head to 1.8 cm. They were present in the longitudinal fissure, and to some extent in the base. In the right temporal lobe, near the

inner extremity, was a tumor 2 cm. in greatest extent, gray, speckled, and streaked with red. In the right cerebellum anteriorly, adjoining the pia, was a similar tumor 2.5 cm. in diameter. Posteriorly, on the same side of the cerebellum was another, 3 cm. in diameter, of which the centre was yellow and somewhat broken down. Smaller tumors were present beneath the pia, all over the base. On section, excess of fluid was found in the ventricles, but no tumors were to be seen there. Numerous ones, however, similar to those already mentioned, were found throughout the brain substance.

It is very remarkable in this case that with so numerous and wide-spread neoplasms throughout the brain, there should have been so few cerebral symptoms — only occipital pain and vomiting.

The pathological findings in the heart were very numerous tumors studding the right auricle, many pedunculated, others cauliflower-shaped, varying from the size of a millet seed to a pea. A few similar tumors occupied the right ventricle, and in the left ventricle were two or three dozen, projecting half-way above the endocardial surface. The left auricle also had a few. Thus all the cavities of the heart showed the neoplasms, as did also the heart muscle and the pericardial surface. This extensive involvement of the heart is what might be expected from the known tendency of sarcomata to make the blood-vessels their channel of invasion.

Among numerous tumors of the lungs was one of the lower right lobe, 5 × 3 cm. From this a large papillary mass projected along the lumen of an enclosed bronchus.

The kidneys showed several small sarcomata beneath the capsule. The same growths appeared beneath the mucous membrane of the bladder, and at the base of the latter organ, corresponding to the so-called third lobe of the prostate, was a flattened tumor 2 cm. in length. Two tumors were found in the right epididymis and one in the penis. The pectoralis, serratus magnus, and intercostal muscles also contained growths.

Case III. — M. K., aged 40, married, born in Ireland. Entered the service of Dr. Mason, Nov. 4, 1890. History of alcoholic excess for years.

For the last two months, increasing weakness: in bed for last twelve days. Cough and pain in chest. Expectoration profuse, white, thick. Nausea and vomiting.

Physical examination showed a marked muscular atrophy, involving supra- and infra-spinati, deltoid, biceps and triceps, extensors and flexors of forearm (except supinator longus, which remains fairly well marked); also the muscles of thenar and hypothenar eminences and the interossi. The arm could with difficulty be raised; rotation of forearm was limited and painful; patellar reflex absent; cremasteric present.

Besides these signs of muscular atrophy, there was noted in the left gluteus muscle, between the posterior-superior spine and the trochanter a fusiform mass two inches long, running obliquely downwards and outwards, cartilaginous to feel. No other tumor was at that time noted. The superficial veins in the iliac region were unusually prominent.

Examination of the lungs showed imperfect expansion, respiratory sounds faint, medium moist râles, with dulness over left base behind.

Within a few days the patient complained of pains in the left frontal region, somewhat intermittent in character. The condition became gradually somewhat weaker. On November 19 the patient noticed for the first time several small lumps, the size of a pea, under the skin of the abdomen, about opposite the sixth, seventh, and eighth ribs on the left side, an inch from the costal border. Another tumor was seen above the level of the anterior-superior iliac spine and a little to the right of the median line. There was no pain, redness, or tenderness in any of these tumors, and the skin was fairly movable over them. The feel of them was cartilaginous. In the ensuing ten days the tumors became a little more adherent to the skin, and a fine capillary injection appeared over the surface. One new lump appeared near the umbilicus. Progressive failure, bodily and mentally, occurred, and the patient died of exhaustion, December 3.

The autopsy was made by Dr. Gannett, 6¾ hours after death.

In the lower lobe of the left lung was found a cavity of the size of an orange, with ragged walls, composed of grayish tissue like that of the cutaneous nodules. Similar tumors were found in both adrenals, and, so far as the record states, nowhere else.

Here the indications would seem to point to the pulmonary nodule as the original one. The extension of the disease was neither wide nor rapid. It is cause for regret that neither brain nor cord was examined in this case. It would have been particularly interesting to know if any neoplasms in the anterior cornua stood in relation to the muscular atrophy, or if the latter condition were due only to the degenerative changes more commonly found in that part of the cord.

Besides the foregoing cases, I find five others in the hospital records on which no autopsy was made, either because of objection of friends or because the patient left the hospital before death. These cases will be more briefly narrated.

Case IV. — A. W. M., 36, single, salesman. Entered the service of Dr. Buckingham, July 12, 1891. For seven months he had had dyspeptic symptoms which still continued. For the last six months he had noticed a swelling of the left side of the neck, which had been treated with iodine, arsenic, and mercurial ointment. Within the last month or two this swelling has diminished, but smaller nodules have appeared, about the size of the finger tip, on the surface of the chest and epigastrium. At entrance there were seven of these smaller nodules counted. They are movable and discrete.

The liver was enlarged, well below the rib margin, and tender to the touch. A tumor was also felt in the epigastrium, which is not very fully described. The left testicle was symmetrically enlarged to the size of a hen's egg, stony, hard to the touch. The patient failed rather rapidly, and died July 21.

Here the original tumor was internal, and, to judge from the symptoms, either involved or encroached upon the stomach. Then came involvement of cervical glands, of the

skin, of the liver, and possibly of the testicle, as there was no specific history to account for the orchitis.

Case V. — Mrs. A. D., age 35, born in France. Entered Dr. Buckingham's service, July 18, 1891. Reports that two years and nine months ago a "fatty tumor," size of a lemon, of seven months' duration, was removed from right breast. There is on admission a cicatrix where the right breast has been removed, but no tumor has returned.

The patient has had a cough for the last few weeks with slightly blood-streaked expectoration. Has a very sharp pain in the right chest, and especially in the middle of the right back. This pain is continuous and keeps her from sleeping. Has lost sixty pounds in five months. Complains of pain in left ankle, numbness, cold, and weakness in left leg. Appetite poor, epigastric distress and vomiting.

At the side of the neck, in the left breast, and scattered in various places over the trunk, are subcutaneous tumors varying in size from a pea to an English walnut. They are hard, non-fluctuating, somewhat elastic, and not tender; are attached to the skin, which in some places is reddened over them. They are most numerous on the front of the chest. These bunches have appeared, the patient says, at various times since the operation for removal of the breast.

Physical examination of the lungs showed no marked dulness; respiration rather harsh throughout, especially at the right apex. No râles were heard. (The patient had been an inmate of the Consumptives' Home.)

The right leg was found to be somewhat atrophied above the knee; it is dragged in walking. Sensation good, but some tenderness over the sciatic nerve. Plantar and patellar reflexes diminished.

The patient remained in the hospital only twelve days, during which she gained somewhat in strength, appetite, and digestion. When she went out she walked quite well with a cane.

Here the original tumor was evidently that of the breast, which was removed and never appeared *in loco*. It seems probable that the pulmonary symptoms were due to an intrathoracic growth, and it is possible that the neuritis of the

left leg may have been caused by pressure of a neoplasm on nerve trunks high up. There were in this case plenty of subcutaneous nodules, but no evidence existed of a growth in any abdominal organ.

Case VI. — J. D., aged 50, married, teamster, admitted April 5, 1889. Service of Dr. Doe. General health good, habits alcoholic.

For 20 years has had a little tumor on the left (?) calf, apparently not troublesome. It has a scab which frequently comes off: this is followed by bleeding.

Six or seven months ago he noticed a lump appearing under the skin of the right thigh, which increased to the size of a horse-chestnut, and then gradually diminished. Soon after, others began to appear, and the number has increased quite rapidly. They are scattered over the whole body, head, and thighs. They are hard masses just under the skin, and vary in size from a pea to an English walnut. Sometimes they cause a slight pruritus. One of these tumors was excised and sent to Dr. Gannett for examination, who reported: "On section, tumor is a dirty-black color and microscopically shows the structure of a medium and large-sized cell pigment sarcoma."

This patient had had a troublesome cough for 6 months, with expectoration and dyspnoea. The physical signs in the chest were merely those of a bronchitis. Here the initial growth was evidently that on the calf, of 20 years' standing. We have no evidence what internal organs were involved, but may suspect the lungs. The patient went home after 20 days' residence in the hospital.

Case VII. — Mrs. S. L., aged 48, married, Jewess, born in Germany, admitted Jan. 4, 1895. Service, first of Dr. Shattuck, then of Dr. Withington.

For one year patient has had severe pain almost constantly in her back, also on both sides of the chest and occasionally in right and left iliac regions. At first she lay in bed some weeks at home and was then admitted to the Massachusetts General Hospital, where she wore plaster jackets for several weeks. She was then fitted with a

leather jacket, which she has worn, off and on, since. None of these supports gave her much relief from the pain, which is now her one cause of complaint. It is referred to the back, right chest, and upper sternum. About 3 or 4 months ago little "bunches" about the size of the end of her thumb began to appear all over the body. These have no pain nor tenderness.

Examination showed a marked kyphosis of the spine, with prominence of the eighth, ninth, and tenth spinous processes. Under the skin of the abdomen, breasts, at front of the right shoulder, on back and on inner side of thighs, are numerous small, hard, movable tumors. These are most plentiful over the abdomen. Between the right scapula and the spine there is a tumor somewhat larger and less movable than the others.

To the left of the epigastrium could be felt a hard lump, the size of a hen's egg, apparently attached to the left lobe of the liver and moving up and down with respiration. The liver extended in the right mammary line from the 5th rib to 2 inches below the costal border. The edge was easily felt, and was uneven and nodular. The glands of the axillæ and groins were enlarged.

The heart was moderately enlarged and showed a systolic and a diastolic murmur. There were signs of consolidation in the left lower lobe, confined to an area just below the angle of the scapula. The urine was normal.

A blood examination made January 8 showed nothing but a slight leucocytosis. A tumor was excised from over the right ilium, and sent to the pathologist, who reported: "Tumor consists of moist, soft, black-colored masses of tissue. Frozen section of these consists of large oval or spindle-shaped cells, with oval, vesicular nuclei. There is no definite arrangement, except a tendency to lie in parallel rows. Many cells contain a large amount of dark-brown pigment granules."

The patient remained in substantially the same condition, complaining bitterly of pain in the shoulders and sides. She could not move in bed on account of it, and was afraid to cough. Slept but little. Later there was some pain in the hepatic region and the abdomen.

February 25 patient tried to walk, but could not stand without assistance. The loss of general strength was, however, slow. She was finally removed from the hospital, March 13.

Here the original lesion appears to have been in the bodies of the 8th and 10th vertebræ. This would be at first naturally considered tubercular, and may, of course, have really been so, though the subsequent development of sarcoma of the skin, liver, and probably of the lung, makes it probable that the disease of the vertebræ was of a similar character.

Case VIII.—P. A., aged 39, single, laborer, born in Ireland. Entered the hospital Aug. 12, 1895, under the care of Dr. Sears, and later of Dr. Withington. The symptoms were acute pulmonary of three days' duration, and it was not until later that attention was called to a tumor of the inner aspect of the right leg, having its centre 3 to 4 inches below the head of the tibia. The tumor is 7 inches in length, vertically, is hard, non-fluctuating, and the maximum circumference over it is $17\frac{3}{4}$ inches as against 12 inches of the left leg. It is painless to the touch, and is covered with dilated superficial vessels. The veins also are dilated on the inner aspect of the thigh, and the glands of the groin are markedly enlarged. The patient says that twelve months ago he noticed a tired feeling in the leg, and that nine months ago the swelling began. He complains of no pain, only stiffness.

A portion of this tumor was later excised for pathological examination, and was reported to be a spindle-cell sarcoma.

The patient's temperature at entrance was 101°, and it continued slightly elevated during the seven weeks which elapsed before his death. It scarcely exceeded 101° at any time, and after the first three days ranged below 100°. The respirations were from 20 to 40 and the pulse never over 120. The signs at first were those of consolidation in the left upper and lower lobes, with fluid below. Twenty-one ounces of bloody fluid were withdrawn August 14 by puncture in the ninth interspace outside the angle of the scapula. The fluid was

of specific gravity 1017, and contained one-tenth of one per cent. of albumen; five days later 24 ounces of a similar fluid were withdrawn from left axilla.

In addition to this trouble with the left side there was a spot of dulness about 4 inches in diameter near the angle of the right scapula, with increased voice-sounds and crackling râles. The patient gradually improved, but presented anomalous physical signs. Posteriorly there was good resonance over the left lung along the spine to the base, with good respiratory sounds. But in the left axilla and over the whole left front to the clavicle there was flatness with absent fremitus and greatly diminished breathing. The heart remained (as it was at first) displaced about $1\frac{3}{4}$ inches to the right. Later, in the left front over a limited area corresponding to the third and fourth ribs near the sternum, there was increased fremitus, bronchial voice, and breathing. Signs of consolidation meantime persisted in the right base, posteriorly, and later an explosion of fine râles was heard near the right nipple. This process on the right increased in activity, invaded the axilla and pleura, and apparently hastened the patient's death. During the last day of his life a few tubercle bacilli were found for the first and only time. No autopsy was allowed.

In this case no certain signs of sarcoma outside of the tumor in the leg were obtained, and no enlargement of the supra-clavicular glands was discovered. The intense flatness of the left front, however, while good respiration could be heard over the back to the extreme base, arouses strong suspicion of an intra-thoracic sarcoma. The tubercle bacilli were not numerous, and may have come from the right lung, which presented more usual signs of tubercular pneumonia.

I should, perhaps, not have ventured to include this last somewhat doubtful case among its predecessors, had I not had a similar one in private practice at about the same time.

Case IX. — Mrs. R., aged about 45, never very strong, and for many years troubled with nervous dyspepsia; had, during the winter and spring of 1895, been gradually losing

strength. In June or July a small tumor, apparently a single enlarged gland, appeared near the angle of the jaw on the right side. It subsequently either retrograded or attracted so little attention that she did not call attention to it till August. At about the end of August (at which time she usually suffered from hay fever), she began to have "asthmatic" attacks. These were often accompanied by a profuse bronchorrhœa, and later by salivation. Then some dysphagia was complained of. At first no physical signs, other than those indicative of spasmodic asthma, could be obtained. But by September an area of flatness in the right back between the inner border of the scapula and the spine was discovered; over it the breathing sounds were diminished, and elsewhere, especially in the right front, they were exaggerated. No enlargement of any other internal tissues could be made out, nor of any lymphatic gland, except, as already stated, at the angle of the jaw.

The patient gradually failed, and had increasing dyspnœa. The flat area rather increased till it occupied 4 or 5 inches in vertical and horizontal diameter. The base and apex of the lung were resonant. The patient died Oct. 14. At the autopsy there was found a large tumor in the posterior mediastinum, about 7 inches in its long diameter and 4 or 5 in its transverse. An examination by Dr. Leary showed it to be a sarcoma. It encircled the œsophagus, causing a deflection of that canal and a narrowing of the trachea. There were also sarcomatous deposits in the liver and both kidneys. The one growth in this case which first served as a tell-tale was the small gland of the jaw. It was doubtless secondary to the mediastinal or original growth.

Etiologically we know very little about this strange affection, except that sometimes trauma seems to play some part in it. The benign growth on the neck of our patient in Case I., which afterward became sarcomatous, was in an exposed place where it was liable to attrition. In a case reported by Willoughby,[1] in a young adult, there was a history of a blow upon the abdomen, three years after which the patient had multiple sarcomata, practically confined to the serous sur-

[1] Lancet, 1896, ii., p. 810.

faces, and occupying the omentum, mesentery, peritoneum, diaphragm, and pleura.

From the cases, now not rare, which have already been published I select one or two for purposes of comparison with those narrated above.

Dr. E. Wigglesworth reported[1] a case of idiopathic multiple sarcoma of the skin, with a retrospect of all recorded similar cases prior to 1876. These were nine in number. Wigglesworth's own case was as follows: A woman, aged 40 years, married, previously healthy, noticed rather suddenly in April, 1872, a band of small spots like mosquito bites across the epigastric and hypochondriac region, occupying an area some 10 inches in width. In January, 1873, there was noticed a bunch in the upper right arm an inch in diameter; also one more prominent, but not so large, on the left eyebrow; also some smaller ones, fifty or sixty in all, generally diffused over the body; and both breasts were found to be infiltrated with neoplasms. The tumor of the brow was removed and submitted to microscopical examination. It was found to be a round-cell medullary sarcoma. There was a quick recurrence of the disease at the site of the excised tumor, a nodule in the leg broke down into an ulcer, then the same thing happened on the right thigh: there was œdema of the legs, diarrhœa, and death. No autopsy.

Dr. F. C. Shattuck reported[2] a case somewhat suggestive of Case VII. in the present series. It was that of a man, aged 36, taken March 6 with severe pain in the small of the back. One week later subcutaneous nodules (shown microscopically to be sarcoma) appeared over the lower sternum. The next day others were found in the axilla, back, front of chest, and biceps. One week later enlargement of the liver was detected, and the patient was dead April 7, only thirty-four days after he first summoned medical aid, and less than four weeks from the appearance of the first subcutaneous tumor. The autopsy showed sarcoma in mediastinum, heart, lungs, pleura, lower dorsal vertebræ, extending into the canal, but not into the cord, omentum, mesentery and intestines,

[1] Archives of Dermatology, January, 1876.

[2] Boston Med. and Surg. Journal, July 26, 1894.

spleen, liver, kidneys, and adrenal bodies. The disease apparently started in the dorsal vertebræ, as in our Case No. VII., but spread with much greaterr apidity. In fact, its rate of progress was quite phenomenal.

Musser[1] reports two interesting cases: A woman, aged 78, developed what was considered to be glaucoma in 1878, and had the right eye removed in 1879. In 1887 a small tumor appeared on the left side of the neck, of the size of a walnut, red, adherent to the skin. One week later another tumor was seen on the right arm. There came a rapid increase till by January, 1888, the whole body was covered with growths from the size of a mustard-seed to that of a walnut. On passing the hand over the skin, it felt like a grater. She died in December, 1888, and the autopsy revealed great infiltration of almost all the internal organs, including both adrenals. There were no symptoms of Addison's disease, however. Here the result showed that what was diagnosticated as "glaucoma" was really a sarcoma of the eye. Yet it was at least ten years after this appeared before the general sarcomatosis became extensive enough to kill the patient.

His second case was much more rapid and more febrile, the temperature ranging from 101° to 104°. It was a woman of 45, who developed a sarcoma of the choroid, which was operated upon in November, 1884. She died in six months with sarcomatous nodules in many of the internal organs, including pancreas, spleen, and both adrenals.

In the matter of treatment of sarcomatosis we have nothing encouraging to report. The disease in all these cases was so widely diffused as to discourage the use of the so-called Coley method for inoperable sarcomas — by inoculation with the toxins of erysipelas and the bacillus prodigiosus. In most of the cases, arsenic, the one drug which has ever gained any success in such cases,[2] was tried, but without avail. That this drug, if given in large, almost toxic doses, has sometimes a marked inhibitory effect on sarcomatosis, even if it does not cure, is shown by the following interesting cases:

[1] Philadelphia Hospital Report, 1893.

[2] Kaposi. Annales de Dermatologie et Syphilographie, 1893, p. 955.

Köbner[1] treated a case of multiple sarcoma in an eight-year-old girl with hypodermic injections of Fowler's solution (mixed at first with a double and later with an equal volume of water). At first from 2½ to 4 drops of Fowler's solution were injected daily. This treatment was begun Sept. 12, 1881, and was continued with somewhat increasing daily doses (7½ to 9 drops) till on Jan. 5, 1882, 12 gm. of the solution had been injected. Under its use the nodules of sarcoma diminished greatly in number and size, and the enlargement of liver and spleen decreased. From January to March, 1882, the treatment was resumed, and the condition as reported in January, 1883, represented a still further gain, the body-weight having increased from 45 pounds to 53. The skin contained but very few nodules, and those that remained were much less pigmented. In this case great improvement certainly followed the medication, but we still lack the ultimate history, which may have followed the at first encouraging, but later disappointing course of the following case of Sherwell's:

Sherwell[2] narrates a case of a man, aged 39, who in February, 1888, developed a sarcomatous ulcer of the posterior part of his left thigh. This was removed April 15, 1888. In May, and later, many new growths appeared on the nates, chest, shoulder, and arms. These grew rapidly. In October, 1888, several of them were ablated. He was then put upon Fowler's solution, which was carried up to from 26 to 30 drops four times a day. Marked improvement in number and size of the neoplasms followed this. The patient said that the arsenic had a good effect on the growths, but a bad one on him. In February, 1889, Dr. J. B. Wheeler, of Burlington, Vt., again operated on a growth, and put the patient once more upon arsenic, giving 25 drops of Fowler's solution, equivalent to 1 gm. of arsenious acid. By the end of June "not the faintest sign of a malignant growth was left on the man," but there were marked signs of arsenical poisoning. The medicine was stopped, and in ten days, while his health had improved, twelve new

[1] Berliner Klinische Wochensch., 1883, p. 21.
[2] Am. Journ. Med. Sciences, vol. civ., p. 443.

sarcomata had appeared on his trunk and extremities. He died the following December. Here arsenic seems to have held the disease in check in a very remarkable manner; but the amount of the drug necessary to do this was so great that the patient either did not or could not tolerate it. It was not, as in Köbner's case, given hypodermically.

VIII.

FOUR CASES ILLUSTRATING A MARKED DEPARTURE FROM THE USUAL PHYSICAL SIGNS OF PLEURITIC EFFUSION.

By Vincent Y. Bowditch, M.D.

My object in reporting the four following cases which occurred in two of my services at the hospital is to emphasize the fact that frequently the typical signs of a pleuritic effusion, especially that of diminished respiratory murmur, may be supplanted by the usual sign of consolidation, viz., marked bronchial respiration; a fact which causes at times a good deal of difficulty in diagnosis, to be decided only by the aspirating needle.

That faint bronchial respiration may be heard in the region of pleuritic effusions is doubtless mentioned in some text-books, but I fail to find sufficient allusion made to the not infrequent cases in which the signs are such as are usually taught to the beginner as characteristic of intra-pulmonary rather than pleuritic disease. It is only comparatively recently that I have had cases brought to my notice in which the *bronchial breathing mixed with râles* has been *very marked* over the seat of effusion; and from my experience with aspiration in these cases I am led to believe that in one or two others which I can recall where in convalescence from pneumonia, days after the return of the temperature to normal, the marked bronchial breathing persisted, and which I attributed to an unresolved condition of the lung, there was a pleuritic effusion present; the amount of fluid, however, probably not being very great. In consequence of this experience I should never hesitate to aspirate under the conditions mentioned, believing that less harm can come to the patient by possibly puncturing a solid lung with a ster-

ilized needle than by leaving a pleuritic effusion to partially hamper the free action of the lung.

Case I. —(Vol. B. 401, p. 124.) A. C., male, 31, single, cigar-maker. Previous history shows nothing of special importance. Entered April 2, 1896.

Personal History. — Bad cough, with malaise, for eight weeks. Gave up work the day before entrance, when he had a chill and a sharp pain in the right breast and shoulder-blade. Considerable expectoration for twenty-four hours; bloody at time of visit.

Physical Examination. — Sputa hæmorrhagic. Dyspnœa.

Lungs. — Good resonance and respiration over left front and back; slight dulness over right front below fourth rib, and here respiration is faintly bronchial. Dulness in right back from 1 inch below spine of scapula, becoming flatness below at base, but not extending into axilla; over this area breathing is *tubular*, more intense in upper portion; voice sounds are *intensified*, and tactile fremitus is *slightly increased*. The apex beat was seen best about in the mammillary line.

April 6. Dulness, amounting almost to flatness, over entire right front and back with *tubular* respiration; a few crepitant and medium moist râles over back and front. From this time on, for several days, bronchial respiration, numerous crepitant râles, and medium moist râles were heard all over the right back, and signs of an extension of a pneumonic process into the left lung were also present.

The temperature came down to normal by lysis.

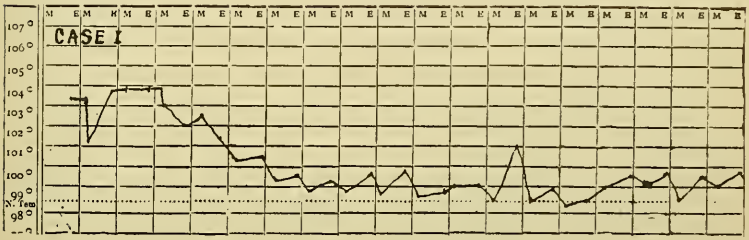
April 25. There was slight dulness in the right apex in front and all over the right back compared with the left. Respiration remained bronchial in the right back, but indistinct in the axillary region.

Previous to this time, from the fact of the persistence of the bronchial respiration, it was thought to be simply a case of unresolved pneumonia, and the possible presence of fluid was not entertained until the persistence of the dulness and a slight lessening of the tactile fremitus in the right axillary region suggested the wisdom of aspirating the chest. May 1, the smallest aspirating needle was inserted just below the angle of the right scapula, and 24 oz. of clear

yellow serum were withdrawn. The day following showed an *entire disappearance* of the *bronchial breathing*, leaving only a diminished respiratory murmur and absence of tactile fremitus.

On May 10 the respiration was again slightly bronchial, but the other physical signs had improved, and he was discharged.

On June 1 he returned for examination, having been in the country for two weeks, and the physical examination



showed a good percussion note and respiration throughout the chest.

Synopsis of Case. — Pneumonia of right lung, with the usual signs of that disease. *Bronchial breathing* persists after fall of temperature and apparent convalescence of patient. Aspiration proves the presence of 1½ pts. of clear serum in the area showing bronchial respiration.

Case II. — (Vol. 401 B., p. 214.) H. N. B., male, 21, single, ward-tender. Entered April 14, 1896. Diphtheria and typhoid fever several years before entrance.

Five days before entrance took cold after nursing several severe cases of pneumonia. Two days later hard cough with tightness across chest. Sputa scanty and whitish.

Physical Examination showed at first nothing but a few moist and sonorous râles scattered about both lungs.

April 22. Eight days later there was a more marked rise of temperature, much dyspnœa, cyanosis, and the general aspect of pneumonia, although the sputa were not rusty, but bloody and slimy. Over one area near the angle of the left scapula *bronchial breathing* and *some crepitant râles* were noticed.

May 1. Ten days later the dulness in left back showed a line of demarcation quite marked about the posterior axillary line. *Bronchial breathing, crepitant and numerous coarse, almost bubbling râles*, were heard over this region. No dislocation of heart. Sputa dirty, slimy, occasionally bloody.

Four days later the space of dulness increased, although not in a manner to indicate a pleuritic effusion especially; that is, the line did not rise in the axillary region. In spite of *harsh bronchial respiration*, however, all over this region, aspiration was resorted to just below the angle of the scapula, and 12 oz. of serum rather brownish and turbid were withdrawn. After this the physical signs gradually improved up to the time of the patient's discharge.

Examination of the sputa showed an absence of tubercle bacilli.

Synopsis of Case. — Typical case of pneumonia. Harsh *bronchial respiration persists* several days after fall of temperature and marked improvement of general symptoms.

Tentative aspiration over site of bronchial breathing resorted to. Withdrawal of 12 oz. of brownish serum. Immediate diminution of bronchial respiration.

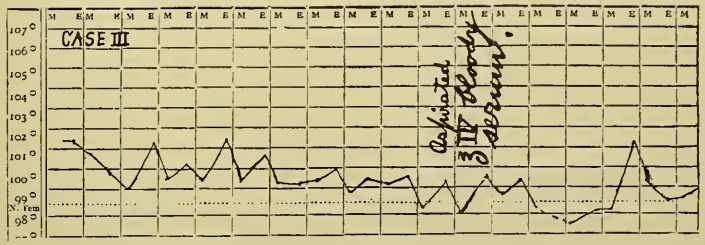
Case III. — (Vol. 401 B., p. 208.) J. J. O'C., 14, male. Entered April 14, 1896. Pneumonia three years before entrance, scarlet fever one year before, and, about five weeks before entrance, acute articular rheumatism.

Two weeks before entrance pain about heart with dyspnœa; feverish. No rheumatic pain at time of entrance.

Physical Examination. — The percussion and auscultation of the heart showed the presence of a pericarditis with endocardial murmurs also present.

Over the lungs dulness was noticed in the left axillary region and at both bases behind. On the left the dulness began 1 inch above the angle of the scapula, over which region the respiration was *bronchial* and there was *whispered bronchophony*. Respiration in the right base also faintly bronchial, with the vocal sounds increased. Later this character disappeared, and friction rubs developed in the right lower back, but the *dulness* and *bronchial respiration* in the left lower back *persisted*.

As the line of dulness extended in an upward curve in the lower axillary region, the presence of an effusion, *in spite of the bronchial respiration*, was thought probable, and aspira-



tion 1 inch below the angle of scapula was tried, and about 4 oz. of bloody fluid were withdrawn.

Six days later the percussion note was more tympanitic in character, and the bronchial respiration was replaced by a lessened murmur.

The patient slowly improved, although the cardiac symptoms persisted, and two months after entrance he was discharged, at which time there was fair resonance over the left back; the respiration was rather harsh with a few indistinct râles or fine friction sounds after forced inspiration.

Synopsis of Case. — Peri- and endo-carditis with pleuritic effusion in left lower back proved by aspiration in spite of marked *bronchial* respiration in that region.

Case IV.— (Vol. 362 A., p. 130.) A. T., female, 20, single, laundress at B.C.H. Entered Oct. 2, 1893.

Previous history excellent, except for "brain fever" as a child after exposure to sun. Strong and well since.

Two days previous to entrance felt a sharp stinging pain

in the right side near the edge of the ribs; increased upon deep inspiration. No chill, no cough. Headache.

Physical Examination at entrance was negative throughout. Temp. 102, 4. P. 88. Resp. 24.

For at least seven days nothing new could be discovered upon examination, but almost continual pain in the right flank was complained of. At the end of that time slight cough began to appear, and extreme dulness increasing to flatness in lower right axillary region was noticed, and the same conditions in the back from 1 inch above angle of right scapula. Over this region was heard faint *bronchial breathing* in various portions, mixed with *crepitant râles* and in places diminished respiration.

Slight amphoric whisper in different parts of this area. *Some râles* noticed in axillary region and in lower right front, but not so marked as behind. Respiration in front puerile. Vocal fremitus faint on both sides; rather less on right side. Impossible to find apex beat.

Four days later, although the bronchial respiration, amphoric whisper, and crepitant râles persisted, from the fact that the dulness slowly moved upwards, and there was slight change of note upon change of position on the right side, an exploring needle was inserted about 1 inch below the angle of the right scapula, and about 29 oz. of reddish fluid were withdrawn.

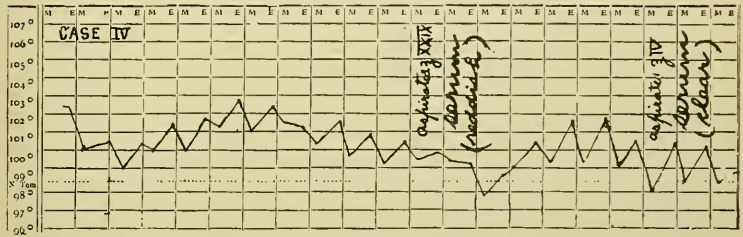
The note made on that date reads as follows:

"The only definite physical sign of pleuritic effusion as distinguished from a pneumonic process was the change of percussion note upon change of position. There was no apparent dislocation of the heart, no special difference in vocal fremitus, while *numerous crepitant râles* and *faint bronchial respiration with amphoric whisper* could be heard throughout region of dulness. Three days after operation, the dulness was about the same. The râles had entirely disappeared, the amphoric respiration persisted, and for the first time the heart apex was distinctly felt outside the left mammillary line. One week after the first operation it was repeated, and 4 oz. of clear serum were withdrawn. The amphoric respiration disappeared after this, leaving only obscure respiration over the point of dulness, which slowly

lessened, and the patient was discharged convalescent one month after entrance."

Two examinations of the serum failed to show the presence of tubercle bacilli or other objects of special import.

Synopsis of Case. — No definite physical signs for a week after entrance. Development of dulness in right back diminishing upwards with *crepitant râles*, *bronchial respiration*, *and slightly amphoric voice* over area of dulness. Tentative aspiration proved presence of fluid.



In Cases I. and II. the general signs of pneumonia were so marked that the diagnosis could be reached almost by the aspect of the patient and by the peculiar soft crackling sound of the respiration, heard without applying the ear to the chest, combined with the short, almost incessant cough so common in pneumonia. The persistence of the bronchial respiration in both of these cases, therefore, as far as the presence of fluid was concerned, was most misleading.

In Case III. the whole appearance of the patient was one which suggested tubercular disease, and the bronchial respiration and dulness in the lower left chest suggested the possibility of consolidation rather than an effusion, the presence of which was proved by aspiration.

In Case IV. the general symptoms gave no aid to the diagnosis, but the bronchial respiration and the *presence of râles* more or less disseminated over the affected area, the absence at first of apparent dislocation of the heart, made the diagnosis difficult until aspiration revealed the presence of fluid.

IX.

ACUTE PERICARDITIS: A STUDY OF ONE HUNDRED CASES.

By George G. Sears, M.D.

The cases forming the subject of this paper include all which could be found in the general index of the Hospital between the fourteenth of January, 1882, and the twelfth of April, 1896, irrespective of whether the pericarditis was the primary affection or occurred as a complication of some other disease. Classified according to the products of the inflammation, 54 were dry, or at least the effusion was insufficient to give distinctive physical signs; 41 were serous, 4 being hemorrhagic in character; and 5 were purulent. Seventy-four were males and 26 females. While no age was exempt, the youngest patient being 9 and the oldest 78 years old, the largest proportion was found in early adult life, 42 occurring between the twentieth and thirtieth years. From this as a maximum, the curve quite rapidly and uniformly descended on either side; thus, from 30 to 34 years there were 13 cases, and from 15 to 19, 12; from 35 to 39, 8, and from 10 to 14, 7. Above the age of 40 the liability appears to rapidly diminish, 8 only being found in the fourth decade, while but 7 were over 50. In 2 the age was not stated. No inference can be drawn from the fact that but one patient was under 10 as to the relative prevalence of pericardial inflammation among children, since they form a very small part of the hospital clinic. Although the occupation of the patients has been classed among the general factors which induce the development of this affection, it seems to have exerted but little influence here, as no marked preponderance were engaged in pursuits necessitating any special exposure. The influence of season, however, was more marked, as was to be expected, from the

large proportion which were secondary to rheumatism and acute diseases of the lungs, very few being admitted during the four months from August to November inclusive. Among the remaining months the cases were very evenly distributed, although a slightly larger number was found in January. A history of the abuse of alcohol was, perhaps, no more prominent than was to be expected among a hundred hospital patients, no matter what their disease, 23 having used it to excess, while 11 confessed to a moderate indulgence.

A striking feature of these cases was the large percentage in which the heart was already affected, 34 showing evidence of some valvular lesion, either mitral, aortic, or both, while in several others degenerative changes in the myocardium were present. This may have been simply a coincidence, but the number is so large that it is more probable that the preëxistent lesions acted as a determining cause. Beside this frequent association with old cardiac trouble, so many of the cases were complicated by, or secondary to, pneumonia, pleurisy, or both, either by direct extension from one to the other, or from a simultaneous infection, that it is difficult, often even impossible, to differentiate the symptoms due solely to the pericardial inflammation, so that but few points in their clinical history are worth noting. Pain was fairly constant, being present in 65 cases, and when absent its place was frequently taken by a sense of oppression in the chest. Its usual position, as was to be expected, was in the precordia or in the left side of the thorax, but in one it was situated only in the back between the scapulæ. Often, however, it was not definitely located, the patients complaining simply of "pain across the chest." Next in frequency was dyspnœa, though, for reasons which have been mentioned, but little stress can be laid upon it. Palpitation and digestive disturbances were comparatively rare. In a dozen or more instances delirium is recorded, at times so active that the patients required restraint, but these cases were so often complicated by other pathological conditions or by alcoholism that figures are valueless. The febrile movement was almost always slight, although occasionally rising to 102.5° or 103° F. for a single observation. If it exceeded

the former figure for several days, even in the rheumatic cases, some other acute process, usually pneumonia or pleurisy, was almost always present. Subnormal temperatures continuing for several days, and with wide daily fluctuations, were not uncommon, even when recovery followed. In one very pretty chart what appeared at first glance to be a well-marked septic rise and fall proved to be the variation between a morning temperature of 96° and an evening one of 99.5°. The highest point was reached in a rheumatic case, complicated by pneumonia, 107.4° being recorded just before death.

Recurrent pericarditis occurred in one case of rheumatic origin without any return of the articular symptoms, the relapses, of which there were several, being confined to the pericardium, but running a course perfectly analogous to those which take place so frequently in acute rheumatism where the disease affects only the joints.

From the point of view of diagnosis two cases may be mentioned as showing the necessity of a careful examination of the back as well as the front of the chest, where the possibility of pericardial inflammation is suspected. In one the friction rub was heard very feebly over the precordia, but was pronounced inside and just above the angle of the left scapula behind; in the other a collection of pus which distended the posterior portion of the pericardium to the size of two fists, its anterior surfaces being glued together by a previous affection, defied detection, and was first discovered at the autopsy. In the former a slight diminution of the friction sound might have rendered it quite inaudible in the usual position although distinctly perceptible behind, while in cases similar to the latter, when the lungs are clear, careful percussion of the back might show an area of dulness whose position might be of great value in diagnosis.

Etiologically acute rheumatism occupied the most prominent position, as it was associated with 51 cases and appeared in the previous history of 4 others. Pneumonia or infection with the pneumococcus was next with 18. In 7 instances chronic nephritis was the primary disease, and in 5 pleurisy. Chronic rheumatism and gonorrhœa are both credited with 2 cases, while 1 occurred in each of the following

diseases: empyema, tonsillar abscess, acute nephritis, hepatic cirrhosis, and chronic fibrous pneumonia. The latter was apparently not tubercular, but no histological examination was made. Phthisis was, however, present in 2 others, one of which was also complicated by empyema, but in both the autopsy proved that the pericardial inflammation was of pneumonic origin, and not the result of infection with the tubercle bacillus. The latter may have been a factor in the 5 cases associated with pleurisy, but in 4 there was no direct evidence; in the fifth the jagged temperature curve, which persisted as long as the patient was under observation, and the aspiration of bloody fluid from the pericardial sac were strongly in favor of such a possibility, but the diagnosis could only be made by inference. Chorea appeared in the history of 3 cases, but in only 1 (a rheumatic patient) was it associated with the pericarditis, and there it came on several days after the onset of the latter.

The 9 remaining cases have been classed as idiopathic, no efficient cause being found, although a history of exposure was given in 2 or 3 instances, but in only 1 was the patient in normal condition before the attack. Six had chronic valvular lesions, the result in one case of 5 attacks of rheumatism, the last 5 months before, and in another of an attack 4 years before. In both the latter a rheumatic origin is possible, the infection either being confined to the pericardium, or else the joint symptoms were so slight as not to be thought worthy of mention by the patient. Another case had markedly atheromatous arteries, a somewhat enlarged heart, and, probably, a mitral leakage; while still another was admitted with a soft systolic murmur at the apex, which persisted during his stay in the hospital, but it remained doubtful whether this was the result of organic or inorganic causes.

Many of the cases occurred before cultures were taken as a routine part of an autopsy, but records of a bacteriological examination were found in 8, in 4 of which pneumococci were found in the pericardial effusion, and in 1 (acute nephritis) the colon bacillus. In a third (chronic fibrous pneumonia) streptococci were demonstrated, and, probably, also pneumococci and the Klebs-Löffler bacillus, but the latter

were not absolutely differentiated. In one case pneumococci had been shown in the sputum, but the organs at the autopsy proved sterile. In another (rheumatism with recovery) colon bacilli were found in aspirated pleural fluid, but no opportunity was afforded to investigate the contents of the pericardium.

Rheumatism occupies so conspicuous a position among these cases, more than half being attributable to it, that a more detailed account of them is given. Thirty-eight were males and 13 females. The youngest patient was a boy of 9, the oldest a man of 52. Only 4 were over 35 and only 5 under 15, but for reasons which have been given the latter figures are no criterion of its frequency in childhood. Between these limits, 15 and 35, if divided into periods of 5 years, the cases were very evenly distributed, although a slightly larger proportion occurred between 20 and 25 than at any other time. So many of them entered with the signs of pericarditis already present that it is impossible to more than approximate the date of its onset in any considerable number. In a few it antedated the appearance of the joint symptoms, in a few others they came on simultaneously, but in a great majority it showed itself within the first 15 days. After that time its development was quite rare, yet in one case the first evidence was found on the 34th day. It was decidedly more common in the first attack than in the second, and in the second than in the third, the figures being 23, 15, and 7 respectively. After the third attack it was much less common, but in one case it came on as late as the ninth or tenth. It does not, however, necessarily follow from this that the liability successively diminishes, since more patients are admitted in the first or second than in later attacks, and no attempt was made to get at the relative proportion in each. It was also decidedly more frequent where the disease affected many joints, five or more being concerned in four-fifths (41) of the cases, and inferentially also, although the records are not always explicit, when the inflammation was migratory and skipped about from one position to another. Yet it also occurred where the articular symptoms were so slight that the patient complained only of transitory pain, more often in the knees, elbows, or shoulders. The probabil-

ity that the infection was particularly virulent is also suggested by the presence of pulmonary complications in nearly one-half of the cases (23), pleurisy being found in 18 and pneumonia in 3, while pneumonia (once on the right and once on the left side) and double pleurisy occurred simultaneously in 2. Infection by contact appears to have been the usual course, as in the cases of pleurisy the left side was more frequently affected than the right, in the proportion of 12 to 1, while 5 were double. Of the 3 simple cases of pneumonia 2 occurred on the left side and 1 was double. In cases also where pleurisy was the primary disease pericarditis was more common when the left side was affected, in the proportion of 3 to 1, the fifth case being double; but with the primary pneumonias the condition was reversed, 8 occurring on the right to 4 on the left side, 3 being double.

But little opportunity was furnished by these cases of observing whether thorough treatment by the salicylates has any effect in preventing the development of pericarditis, as in nearly every instance it was either present at the time of entrance or appeared only a few hours later, or else the joint symptoms had so far subsided that the drug was not given. Only 6 patients had obtained an amount sufficient to bring them at all under its influence before the friction rub was discovered, and one of these received but three doses of fifteen grains of the soda salt. The other 5 received an amount which varied from ten grains every hour for two days as a maximum to fifteen grains three times daily for three days as a minimum. All that can be said is that so far as is known, since it is impossible to tell how much they may have received before admission, the great majority of the cases were not under its influence, but that in a small number it was unable, in the doses given, to prevent its development.

Based on the total number of 100 cases, the prognosis of pericarditis must be considered grave, as 43 per cent. died and 4 were discharged unrelieved; but when it is considered how frequently it occurred as a complication of some other disorder, this estimate of its gravity must be shaded somewhat, according to the diseases of which it formed a part. When associated with hepatic cirrhosis or

nephritis either acute or chronic, every case but two terminated fatally, and of these exceptions one was discharged unrelieved, while the other was evidently not connected with the nephritis, but was of rheumatic origin and went on to recovery after the manner of such cases. Nor is the fatal ending always to be attributed solely to the pericarditis, since its onset is often but one form of expression of the critical condition of the patient, or at most may have hastened the end by adding another item to the load which he was already carrying. So far as these figures go a similar observation is applicable to cases associated with other chronic diseases, all those complicating phthisis, fibrous pneumonia, and chronic rheumatism being fatal with one exception, a case of chronic rheumatism discharged unrelieved. Where, however, the primary disease was of an acute infectious nature the results were somewhat better, yet the mortality rate was still very high except in rheumatism. Fifteen out of the 18 cases classed as pneumonia, for example, died, but this undoubtedly over-estimates the true rate, since several fatal cases are included in this list which would have been overlooked had not an autopsy been held, as the pericardial affection had not manifested itself by any physical signs, an occurrence probably not uncommon in pneumonia, whatever the outcome, its signs and symptoms masking those of the secondary disease. Both cases complicating gonorrhœa, 2 out of the 5 cases of pleurisy (another was discharged unrelieved), and the single case of empyema were all fatal. The case complicating tonsillar abscess recovered. The marked contrast in the result between those cases which were secondary to acute rheumatism and those which complicated all other affections is shown by the following figures, 10 only of the former dying out of 51, while 32 out of 40 of the latter were fatal, and 3 were discharged unrelieved.

Of the 10 rheumatic deaths 2 had pneumonia, 3 pleurisy, one of whom was also suffering from old valvular disease, and one had pneumonia, serous pleurisy, and old endocarditis. Two others had advanced cardiac lesions, and another died of delirium tremens. The tenth entered moribund, and a satisfactory examination was impossible,

but the presence of a pericardial effusion was demonstrated by a post-mortem aspiration of the sac.

Of the 9 so-called idiopathic cases but one died, and he was also suffering from a chronic valvular lesion. Another with the same complication was discharged "unrelieved," a term which applied more to the valvular than the pericardial affection, the signs of which were fast subsiding.

In view of these results it seems justifiable to say that in itself acute pericarditis is not a very serious affection, but when it comes on in the course of some chronic disease, or when the integrity of the heart has been already invaded by previous valvular lesions, when pneumonia or pleurisy is also present either as the primary disorder or as a coincident complication, or when it is due to a general septicæmic process, as in the gonorrhœal cases, the outlook is serious.

The medical treatment given may be dismissed in a few words, as it was entirely symptomatic, save that in some instances an ice-bag, more rarely a poultice, and still more rarely a blister, was applied to the precordium. The subject of paracentesis, however, deserves fuller discussion, although I have been unable to find any mention of its being attempted in more than 4 of the 46 cases where effusion could be suspected from the physical signs. In a large number of them it was so slight that the question of aspiration evidently did not arise, in others the prompt absorption of the fluid confirmed the wisdom of the policy of non-interference, but in a few of the fatal cases no explicit explanation could be found in the records of why it was not done, although probably, as most of them were complications of some serious process, it was thought that the critical state of the patient was due to other conditions than the presence of fluid, and that puncture would add to his discomfort without hope of granting him any relief. The necessity for puncture may be stated in general terms to arise when the action of the heart becomes embarrassed by the amount of the effusion, but a consideration of these cases also shows that the time must vary somewhat according to the disease with which the pericarditis is associated. In acute rheumatism, for example, the ten-

dency toward recovery, even when the effusion is very large, is so strong that in most instances nature may be allowed to take its course, whereas in others a prompt resort to aspiration is imperative. This would seem to be notably true of pneumonia, from the possibility that the fluid may be purulent, four of the five cases where the effusion was of this character being found in connection with that disease, while the fifth occurred as a complication of empyema, which may have been due to the same cause. The disappointing results which have so frequently followed permanent drainage of the pericardial sac might at times be averted if the diagnosis had been made promptly before the heart had become weakened by the continued presence of the fluid. That the danger arising from wounding the heart is theoretical rather than real received another illustration in one of these cases, when the needle thrust into the sixth interspace just to the right of the sternum entered a "solid body which pulsated," and caused it to describe an arc of one and a quarter inches with each beat; no harm resulted. Of the three other cases the site selected was in one in the fifth interspace on the right, and in another in the fifth just to the left of the sternum. In the third, fluid was obtained in the same interspace on the left just inside the nipple line; while an attempt with a hypodermic needle in the fifth right space failed, another attempt made later in the fourth left space slightly inside the mammillary line was successful.

X.

IDIOPATHIC INTERNAL HYDROCEPHALUS (SEROUS MENINGITIS) IN THE ADULT: A REPORT OF THREE CASES.

By Morton Prince, M.D.,

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On October 12 last I was asked by Dr. J. C. Munro to see a patient in the surgical wards of the City Hospital. The patient, a woman, had been admitted to the hospital about four weeks previously on account of injury to the head. She had been kicked about the face and head by her husband. This was about four o'clock P.M., and she was said to have been unconscious until about midnight of that day. The next day (September 15) she was admitted. On entrance the records state "much swelling of left face; whole left face bruised and ecchymosed; some ecchymosis of left side of neck; slight abrasion of left arm and chest; both eyes blackened; marked tenderness over face and entire head; no signs of paralysis." T.: 100.

During the following four weeks (until October 11) she had exhibited mostly symptoms of a puzzling character; among them irregular but high fever, mild chills, severe headache, obstinate vomiting, and pain in the back of the neck were prominent, but not continuous or co-existing. At first there had been delirium, but later her mind seems to have been clear, until the fourth week. Unfortunately the hospital records are not as full as could be wished in view of the future events, but a study of them with the additional information derived from those in attendance on the case shows the conditions to have been substantially as follows: The above general symptoms were most marked during the first six days; after that improvement set in, and during the fol-

lowing three weeks her condition was fairly comfortable, and, excepting that the fever continued and at one time one symptom was prominent and at another time another, she might be thought to be convalescing; but there was a steady and gradual failure of strength. Headache and vomiting were present at times, as well as pain in the back of the neck.

Dr. Bullard saw the patient the day after entrance, and found no objective symptoms of injury to the brain; tenderness of the head and face, headache, and vomiting were the most prominent symptoms. T.: A.M. 104.2; P.M. 104.5.

September 17. (Third day.) "Temperature has dropped about 3 degrees. Patient complains chiefly of headache and also of general pain. The vomiting continues. Was quite noisy and delirious last night. Seems mentally clear to-day." T.: A.M. 102; P.M. 100.8.

Fourth day. "Patient improving, for the temperature is dropping. The headache is less severe, and though there is still some vomiting patient says she feels better." T.: A.M. 98.6; P.M. 99.8.

Fifth day. "Patient again shows a high temperature, but the subjective and objective symptoms are no worse. Still complains of headache. Vomits quite often." T.: A.M. 104.5; P.M. 104.5.

Seventh day. The headache and vomiting had subsided, but the patient complained chiefly of *pain* in upper back and in the *back part of neck*. "Diarrhœa for the past two days." Temp. still up, 105°.

On the 26th (eleventh day) all the objective symptoms had ceased. Dr. Bullard, who again saw the patient, was unable to find evidences of cerebral disease, and suggested in view of the exacerbations of temperature and chills the possibility of malaria, and advised quinine. (This gives an idea of the negative character of the symptoms at this time.)

Three days later Dr. V. Y. Bowditch saw the patient, but was unable to make a diagnosis. Mental symptoms had again returned, but during the following thirteen days patient continued fairly well so far as local symptoms were concerned, though in general strength she was going down-hill.

At one time pain in the back of the neck, at another time headache, at another vomiting, was prominent. During the latter week of this period she became noisy at night. It was now learned that for some time before entrance to hospital her actions had been peculiar. She had "had freaks of leaving home suddenly without apparent reason and returning after some time." At the end of the fourth week (October 11) local nervous symptoms of importance were noted for the first time, as follows: "Condition has not changed materially until to-day. This morning right pupil was found to be dilated and the left contracted. Patient had a convulsion of the right arm which began in the thumb and ran upward. Had some twitching of the left arm also. Continued to have twitchings in both arms all day. Some twitchings of right side of face. Complains of severe pains in back of neck. For the past week has been noisy at night; seems rather dull and stupid to-day."

October 12. "Slight twitchings of both arms and of the right face continue. Right pupil *less* dilated. Still complains of pain in back of neck." In the afternoon of this day I first saw the patient. She was dull and apathetic, so that when testing the ocular muscles it was with some difficulty that I could induce her to follow the finger with her eyes, or that I could examine the field of vision. The right pupil was dilated and stable. Left pupil slightly dilated and stable (third nerve). Paresis of the right external rectus (sixth nerve).

"There is marked rigidity of the muscles of the back of the neck, as well as tenderness of this region. Any attempt to move the head causes considerable pain about the upper cervical vertebræ. Pressure over the vertebræ is likewise painful. She lies with a pad under the neck for relief. Protrudes tongue straight." (I thought there was slight paresis of the right lower facial muscles, but, as this was not observed the next day, I thought this must have been an erroneous observation. In the light of future events, I now think this observation was probably correct.) No anæsthesia. Nothing remarkable about reflexes. No paralysis of the arms or legs, but the arms seem to show more resistance to passive motion than normal; a sort of spastic

or rigid condition by which attempts to suddenly flex and extend the joints induce contraction of the muscles. This is not marked, but it is unmistakable. (This symptom I think worth noting, and one which probably has considerable diagnostic significance.) Incontinence of the bowels.

October 13. House officer reports that in early morning patient mentally much more dull, etc. To my surprise at visit (about 11 A.M.) patient is comparatively bright; mind fairly clear; laughs; apparently natural, but speaks of an imaginary visit which she says she has made while in the hospital. When asked if she really made the visit or if she dreamed it, she considers for a moment and then says that she dreamed it. Memory fair, but does not remember origin of illness, etc. Still mind not normal. Temperature lower. Abdomen retracted and firm. The paretic condition of ocular muscles is more marked. Right internal rectus is paretic, and the eye does not move downwards as well as left. Field of vision tested by finger normal.

October 14. Change again for the worse; moderate rise of temperature. Mind much more dull and stupid, even, than on 12th. Ocular paralysis more marked still. "Ptosis, right eye. General condition worse, evidently failing. (*No optic neuritis.* Media and fundi oculorum normal (Dr. Bossidy). Examination of ears by Dr. Leland revealed nothing abnormal.)" It seemed evident that the patient was going to die.

On analyzing the symptoms of this case for the purposes of diagnosis, it was evident that we had to do with a cerebral disease which appeared to be the consequence of injury. The symptoms were local and general.

The general symptoms which had been noticeable during the course of the disease were: irregular fever, slight chills, headache, vomiting, stupor, delirium.

The local symptoms were: 1, cervical rigidity, tenderness and pain; 2, paralysis of the right sixth nerve; 3, paralysis of right third nerve; 4, paralysis of left (both) pupils; 5, retracted abdomen; 6, mild rigidity of both biceps (arms); 7, localized spasms; (8, temporary weakness of right seventh nerve).

It is noticeable that the local symptoms were latent; that

is, that they did not develop until the fourth week of the illness, and that up to that time there was nothing that directed special attention to the brain as the seat of the trouble aside from the fact of the injury to the head.

The general symptoms also showed a peculiarity that should attract attention, although I did not give the weight to it that I should have done, viz., there was a great variability in their intensity (at one time one symptom being the most prominent, at another time, another), while the general condition of the patient, with the exception of the temperature, showed a tendency to improvement followed by relapse. This variability was marked even during the final relapse, after the local symptoms had developed, when the patient was comatose or delirious at one time, and clear at another. The temperature was very irregular, being at times as high as 103°–105°, at other times normal. The temperature taken every four hours showed irregularity also.

In making the diagnosis that I did, I was led by the following considerations and reasoning: The history indicated that we had to do with a traumatic affection. The general symptoms (chills, fever, headache, vomiting, delirium, stupor), looked at *aside from their course*, were compatible with meningitis, sinus thrombosis, abscess, and, possibly, with cerebral laceration. The local symptoms (paralysis, spasms, cervical rigidity, etc.) by themselves were strongly indicative of meningitis of the base. But it seemed extremely improbable that such a meningitis, presumably purulent, should continue for four weeks without producing local symptoms; in fact, should run a latent course, during which a general improvement should occur, and then end with a sudden exacerbation and development of paralytic symptoms of the basal nerves.

Sinus thrombosis could be excluded by the absence of middle-ear disease, injury to the skull, and all evidence of septic infection.

Cerebral laceration was incompatible with the course of the disease.

On the other hand, it seemed to me that the symptoms were compatible with and explainable by abscess of the brain.

Trauma is known to cause abscess, which also may run a latent course. It seemed to me at the time that the general symptoms were explicable by a latent abscess, which finally by pressure, or possibly by rupturing and thereby exciting a meningitis of the base, had caused the local symptoms. The strongest point against this theory was the temperature, which in latent abscess is said to be usually normal or subnormal; but a study of recorded cases showed that this statement is too general, and that fever is not uncommon. Besides, in fact, fever is also uncommon in acute hydrocephalus or serous meningitis.

For reasons unnecessary now to go into, the most likely location of such an abscess seemed to be first the cerebellum, and next the temporo-sphenoidal lobe. Accordingly, while recognizing the uncertainty of the diagnosis, I felt justified in advising an exploratory opening. On the 25th Dr. Munro operated, exploring first the cerebellum and then the base with negative results. Not finding any pus in the cerebellum or about the base, it was decided to make a second opening over the temporo-sphenoidal lobe, but before this was completed it became evident that the patient was bearing the operation badly, and it was thought best not to go farther.

The patient only partially regained consciousness after the operation, and continued to fail. Death took place on the early morning of the 18th, the third day after the operation.

Autopsy, Oct. 19, 1896, 32 hours *post mortem*, by Dr. F. W. Draper.

The body was that of a woman 29 years old, greatly emaciated.

There were the scarcely visible remains of ecchymoses in the left temporal region, without definite outlines, and yellowish in color, with a bluish tinge.

The left pupil was larger than the right.

The left temporal muscle showed a slight degree of infiltration with blood.

The skull was not fractured and showed no injury whatever, except the recent surgical lesions.

The dura was normal.

The surface of the brain at the vertex *showed complete obliteration of the sulci and flattening of the convolutions*, with injection of the vessels of the pia; the cerebral surface was dry and sticky, but not inflamed.

On palpation of the brain laterally there was abnormal elasticity.

At the base there was more than the normal amount of cerebro-spinal fluid, with a moist and sodden state of the brain tissues exposed.

The vessels at the base were normal.

There was no pus in the arachnoid spaces.

Section of the roof of the lateral ventricles found those cavities dilated to about three times their normal capacity; they contained clear fluid with a yellowish tinge to the amount of five fluid ounces.

The ependyma was pale, slightly swollen, velvety, showing a sodden aspect.

The velum interpositum was pale, swollen, and moist.

There was no appearance of injury, old or recent, on section of the cerebrum.

The brain-substance was moist, but not injected.

The heart, lungs, spleen, stomach, pancreas, intestines, liver, gall-bladder, kidneys, supra-renal bodies, great vessels, womb, bladder, and ovaries were normal.

Case II. — C. G., housewife, aged 30. Previous history given by Dr. R. C. Macdonald, under whose constant care she was from August, 1888. Well and strong until second confinement in 1891; then never well since. A pronounced neurasthenic "of that unsatisfactory kind that nothing seems to help;" sometimes better, sometimes worse. Chief suffering at menstrual periods; that is, attacks of prostration, vomiting, headache, abdominal pain and great tenderness, extreme wakefulness and nervousness. Sometimes slight chills and slight fever; no stupor or delirium. Between attacks fairly well. Attacks grew progressively worse and lasted about two weeks. During last year vomiting was a prominent symptom. Neurasthenic and other symptoms were thought to be due to ovarian disease, and ovariotomy advised. (At the autopsy cysts were found.) Dec. 10,

1896, well, excepting for a cold. December 19, one of her menstrual attacks.

December 26, headache began; said to have been quite well since December 19. On December 29 reported better, excepting for severe headache, but not seen until January 2; then chills; temperature, 103; headache, vomiting, etc. Diagnosis: Suppressed menstruation, peritonitis, subacute and general inflammation of the pelvic organs. Admitted to Boston City Hospital, Jan. 5, 1897; service of Dr. A. L. Mason. Patient stated that previous to admission, chills of an indefinite intensity and character. Condition on entrance: Complains of pains all over, and especially in the head and neck; frontal and occipital headache; also an area of pain along the sagittal suture; neck is very sore, and movement of the head causes pain. Some, but not localized, pain in the abdomen, also in genitalia and across chest. Physical examination: Organs negative; knee-jerks much diminished; no ankle clonus; no œdema or anæsthesia; tenderness of the muscles of neck with tendency to retraction. Temperature, 100: pulse, 80.

Continuation of this condition for about twelve days. Examination of the blood for malarial organism, negative. *Slight optic neuritis;* no otitis. During the first two weeks after admission the temperature was very irregular, the highest point reached being $103\frac{1}{2}$, while at times, for short intervals, it was normal. After the first two weeks, temperature was normal or sub-normal. Urine at first normal, but at one time contained one-half per cent. albumin, blood, and casts. Thirteenth day after admission, change for the worse; comatose; involuntary movements of the bowels and bladder. This condition persisted during the following six days when Klebs-Lœffler bacillus was found in the throat without inflammation. Patient removed to the contagious wards (South Department) to care of Dr. McCollom.

Records of this department state condition on admission as follows: Pulse slow, regular, good volume and tension; pupils equal and react normally; no retraction of the head; slight tenderness over nape of neck; intelligence stupid; heart, lungs, and throat negative; decided muscular weakness.

For a short time after admission patient obliged to be restrained to be kept from falling out of bed, which she did once or twice. Temperature slightly subnormal during first three weeks, after that normal. Pulse varied between 60 and 90 degrees.

Ten days later it was noted that the facial expression was that of a dement. Facial muscles smoothed out: pupils became dilated and reacted sluggishly to light and accommodation. During the following four weeks patient remained in the same condition of dementia. The coma had passed away, but the intelligence varied: sometimes the patient seemed brighter, and at other times more demented: occasionally some delirium. A good deal of nausea and vomiting, and more or less headache. But excepting condition of the pupils, no focal symptoms; no paralysis or anæsthesia or tremor, but general muscular weakness. Speech, muscular coördination, and reflexes normal. On several occasions the house officer was called at night because of the poor condition of the pulse; in a few minutes it would become of fair strength; these spells similar to the one before her death.

March 4. No special change, save that for the last few days has complained of constant frontal headache; says, "I believe my head will burst." Some vomiting. Temperature subnormal for the past six days: pulse about 60. In the afternoon an attack in which the pulse became several times alternately almost imperceptible and of fair strength. Half an hour later death. Duration of illness about eleven weeks.

From the above it will be seen that the prominent symptoms in this case were: Impairment of consciousness, viz., delirium, stupor, coma, and dementia; the last simulating, as was thought at one time, general paralysis. Chills and fever at first, later normal and subnormal temperature; rapid, followed by slow pulse; abdominal pain and tenderness, and cervical pains; severe headache; nausea and vomiting; optic neuritis; muscular weakness, but no paralysis or anæsthesia. Some of these symptoms appeared and disappeared during the course of the disease, which exhibited temporary improvement with relapses. The demented facial expression, a part of the general muscular

weakness, is worth noting, and absence of spasms. The different diagnoses of different attending physicians give an inkling into the general picture of the disease at different times: "Peritonitis," "Cerebro-spinal Meningitis," "General Paralysis."

Autopsy: Kidneys: weight, 300 gms. Very firm, of a dark-red color. Cortex injected. Relation of cortex and pyramids normal.

Both ovaries cystic, cysts varying in size from a small pea to that of a walnut. Bilateral laceration of cervix.

Brain: weight, 1095 gms., small. Convolutions flattened markedly over convexity, particularly over frontal lobes; in places practically abolished. No areas of softening. The pia strips easily, leaving a moist, soft, smooth surface. The gray matter has less color than normal. Brain substance easily torn, clings to knife. The punctæ cruentæ absent. Ventricles contained about 150 plus cc. of clear serous liquid. Ventricles markedly dilated, particularly the fourth ventricle. Ependyma smooth, shiny, no adhesions or roughenings anywhere. Brain markings normal except that basal ganglia are paler than normal. Vessels at base show no sclerotic changes. Cerebellum and medulla moist, otherwise normal.

Cervical and beginning dorsal cord soft, flattened out as cord is laid across finger. Markings less distinct than normal. Other organs not remarkable.

ANATOMICAL DIAGNOSIS.

Hydrencephalus with œdema of brain. Hypostatic congestion of lungs and kidneys. Slight arterio-sclerosis. Cystic degeneration of ovaries; bilateral laceration of cervix.

Case III. — The following case, which I saw in consultation with Dr. Henry F. Leonard, probably belongs here, although, as recovery took place, the diagnosis must remain largely speculative, and rest on exclusion. Mrs. B., middle age, dressmaker. Condition at time of consultation: Semi-comatose; aroused with difficulty; temperature normal or subnormal; no paralysis; incontinence of bladder and

bowels; urine normal; heart negative; no pulmonary symptoms; pulse weak. Patient seemed moribund, and an absolutely unfavorable prognosis was given. The history, which it should be said Dr. Leonard has given me from memory, is as follows: *Onset:* Well until the day she was taken ill; worked during forenoon, but severe headache, for which she consulted Dr. Leonard. Besides headache felt as if she was falling backwards; "eyes were blurred at time of first visit." *Progress:* Headache continued; no vomiting at first, later several attacks; pain in almost every part of body; screamed when touched or when moved; temperature normal at first, later subnormal; no paralysis, anæsthesia, or spasms; urine normal; no cough or pulmonary symptoms; delirium; muttered much at first, talked to imaginary persons, then coma or stupor; more or less unconscious for three weeks or longer; gradual loss of flesh and strength each day; "ice-cold" extremities; dilated pupils; low respiration, slow pulse; nourished by rectum. "For about two weeks seemed to be on verge of collapse." "During the illness, and for several months after the acute symptoms had subsided, she had a vacant, idiotic expression" (facial paresis?). Gradual recovery. *Duration:* Two months. Fully six months before headache was gone—much longer time before she could work. Eyes so weak that she could not see for several months.

No other diagnosis than serous meningitis seems possible in this case. The disease was plainly cerebral, and if cerebral, probably a meningitis; the absence of fever, the prolonged course, complete recovery, absence of palsies, render the purulent form unlikely, and point strongly to the serous variety.

For our clinical knowledge of serous meningitis, or primary idiopathic hydrocephalus, in adults, we are chiefly indebted to Quincke. Before Quincke's monograph several cases had been reported by different writers (Huegenin, Eichorst, Oppenheim, Annuske), and the later text-books contain brief references to or descriptions of the affection. Eichorst's paper was a valuable contribution, but all the later accounts are for the most part based on Quincke's original study. Most are very meagre and insufficient, and give a very inexact picture of the disease. Oppenheim,

however, has given in his text-book a very clear account of the affection. In a later paper Quincke has reported ten additional cases, and makes a further contribution to the subject. But even Quincke's description will probably have to be modified in the future, as many of his cases never came to autopsy, and therefore the diagnosis in these cases must be open to suspicion. Post-mortem findings have been obtained, however, in enough cases to establish the disease and its chief clinical manifestations. The probably frequent occurrence of the affection, its importance, and the very brief references or descriptions that are to be found in English literature render a very short *résumé* here of our knowledge desirable. The following account is for the most part based on Quincke's monographs:

(1) Wolkmann's Sammlung, 1893, No. 67.
(2) Zeitschrift f. Klin. Med., 1891, 19, p. 181.
(3) Deutsche Zeitschrift f. Nervenheilkunde, 1896, ix. p. 149.

The fundamental conception pertaining to the affection is that a meningitis, particularly of the ventricles, may give rise to a simple serous effusion, as well as a purulent one; just as an inflammation of the pleura may cause serous effusion into the pleural cavities or one of the synovial membranes into the joints. Thus we may speak of a serous meningitis or a purulent meningitis. Hitherto it has been customary to picture meningitis only in its purulent (or tubercular) form. By bringing meningitis into analogy with inflammations of other membranes (pleuritis, pericarditis) we enlarge our conception of the disease.

As such a meningitis may occur at all ages and give rise to collections of fluid in the ventricles, we have a *primary idiopathic* internal *hydrocephalus of adults*, as well as the classical form of children.

The causes, so far as known, may be regarded as trauma, mental strain, alcoholism, otitis media, and acute infectious diseases.

The affection may be either acute or chronic.

The acute form in its symptoms simulates purulent and tubercular meningitis.

The chronic form presents symptoms so clearly resembling tumor that it is usually diagnosed as such. According to Quincke in another variety of the chronic form the symptoms are those of neurasthenia. It may be pointed out, however, that as the conclusive proof of an autopsy is necessarily lacking in such cases, the existence of this neurasthenic form must be open to doubt, and must rest on theoretical considerations. The previous neurasthenic condition in Case II. above is strongly suggestive of this view.

The affection is not so rare as would appear from the paucity of reported cases, the acute cases being mistaken for purulent meningitis and the chronic ones for tumor. Even when at the autopsy an effusion is found, it is not customarily regarded as pathologically a sufficient cause of death.

The cases may be further classified as follows:

I. Acute onset.
(*a*) With acute course.
(*b*) With chronic course.
II. Chronic course.
(*a*) With chronic progressive course.
(*b*) With acute exacerbations.

The symptoms, as in other brain affections, are general and local, and depend largely upon increase of pressure. The general symptoms are headache, vomiting, fever, somnolence or stupor, delirium, convulsions, optic neuritis. The local symptoms are paralysis (especially of the cranial nerves), exophthalmos, cervical pain and rigidity, hyperæsthesia, pains in extremities, etc. It is by its course and greater or less intensity of individual symptoms that it is to be distinguished from other forms of meningitis and tumor.

When the onset is acute it may resemble purulent meningitis, but more often it is slower, as in the tubercular form; but even the latter, in adults, is more rapid and more continuously progressive. Nevertheless, there are cases which are apoplectiform in their onset, with loss of consciousness. The *pulse* is often slow. *Fever* is either absent or only slight, of short duration and irregular course. (To

this Case I., above reported, is an exception.) The *headache* is diffuse, or located in forehead or occiput, of varying intensity and sometimes periodic, or with periodic exacerbations. Usually, some days after the onset, *dulness of consciousness* is observed. As a rule, this is manifested later than in purulent meningitis. It is only in fatal cases that this is continuous and profound. Usually, like headache, it is of varying intensity and alternates with, or is associated with, *unrest, delirium, and sleeplessness.* *Vomiting* is common. *Rigidity of the neck*, with tenderness and pain of motion, may be prominent. (This was marked in Cases I. and II.) *Paralysis* of the cranial, particularly ocular and facial, nerves may be present, though not usual; that of the sixth is most common, it being most subject to pressure on account of its course. These paralyses are apt to be slight and of varying intensity. The *pupils* are unequal and react slowly or are stable. Oppenheim describes weakness of the extremities as common. *Spasms*, more or less diffuse, may occur. An important finding is *optic neuritis*, with atrophy. This is more frequent than in the other forms of meningitis. In the chronic cases it is frequently associated with headache, vomiting, and mental dulness as the cardinal symptoms, thus simulating tumor; but after weeks or months such cases may end in recovery. The visual defect, instead of blindness, may be that of bi-temporal hemianopsia due to pressure from the dilated third ventricle upon the optic chiasm.

Other symptoms are exophthalmos, hyperæsthesia, pains, and intention tremor. In Case I. rigidity of the abdomen and arms was present. A demented facial expression was noted in two of the above cases.

The acute cases may after a course of some weeks end in complete or incomplete recovery or death, or become chronic. A remaining optic atrophy may be the sole indication of past cerebral disease. The chronic cases may pursue a varying course, with ups and downs and acute exacerbations. Such an exacerbation may, in the absence of a complete history, give the erroneous idea of an original acute attack. (In Case I. it is a matter of doubt whether the trauma caused such an exacerbation, or an original

attack.) They may continue for years, ending finally in recovery or in death. For the diagnosis, which at present in most cases must be extremely difficult, Quincke lays stress upon the great variations in the intensity of the symptoms from day to day; at one time one symptom, at another time another comes to the foreground. In the chronic cases the occurrence of remissions and intermissions must largely be relied upon to distinguish them from tumor, and when the not very common focal symptoms (palsies, etc.) are present, the fact that instead of progressively deepening, as with tumor, these signs have a temporary or varying existence.

The pathological findings are for the most part limited to the accumulation in the ventricles of clear fluid which does not materially differ from normal. Quincke makes the point that while the effusion into the arachnoid from cortical meningitis is almost always turbid, and therefore more or less rich in cellular elements and albumin, the reverse is the case in meningitis of the ventricles.

The ventricles may be enormously distended and the pressure so increased that convolutions may be flattened and the sulci obliterated in appearance. The changes in the ependyma seem to be limited to hyperæmia in the acute stages, and to some slight thickening and change in texture (described as smooth, velvety, granular, sodden) in more chronic stages. The pia may be hyperæmic also, and share somewhat in the process. Quincke, in discussing the pathogenesis, likens the affection to angio-neurotic acute œdema of the skin, an analogy which renders intelligible the sudden development and variability of tension (symptoms) observed.

It is not quite clear to my mind that the effusion is to be regarded as of an inflammatory character. Certainly in Case II. above, the condition of the ependyma (not yet microscopically examined) does not suggest inflammation, and the same may be said of the findings in some of Quincke's cases. The pathology of the effusion seems to me to be obscure and deserving of further research.

As to treatment, Quincke ascribes recoveries to the use of mercury. Lumbar puncture has its advocates. In cases which pursue an unfavorable course and a fatal issue seems

imminent I should be inclined to advise tapping the ventricles, although much might be argued against this procedure on the ground that its effect would be likely to be only temporary.

Case IV. — The following case is of interest in this connection, although the cerebral condition was complicated by or caused by a sunstroke and the nature of the meningeal effusion may be questioned. At the autopsy chronic ependymitis was found, but the serous effusion was confined to the convexity of the brain. If this effusion can be properly regarded as that of a meningitis and not œdema, the case would be an example of the serous form of external meningitis.

J. D., age 15, school-boy. Previous history: boy has always been mentally backward (probably from not having gone to school until 12 years old), but physically well.

Present illness: had been playing out-of-doors in the sun all day — the day of entrance; in afternoon was sent on an errand; later discovered on a doorstep in unconscious condition. Admitted to hospital, service of Dr. Jackson. Condition on entrance: unconscious; head retracted, cyanotic, hot, dry skin; breathing rapid and noisy. Eyes rotated upward and to left; pupils pin-point and stable; conjunctivæ injected; pulse regular, rapid, poor strength and volume; temperature 110; arms slightly flexed and rigid; legs negative; reflexes present; other organs normal. Treated with ice-cold sponging and packs. Temperature reduced at first; later, rose; irregular; fell to normal on the fifth day, then rose and continued between 102 and 103. Profuse vomiting and involuntary dejections. Unconsciousness continued for three days. Temperature required several cold packs each day; nourishment taken; marked rigidity of the neck, trunk, and extremities.

Fifth day. Patient seems conscious, though stupid. Will answer a question by yes or no. Temperature still up. Pulse fairly strong. Three sponge-baths given to-day.

Ninth day. Pupils small, left being somewhat larger than right; neck rigid; constant convulsive movements of extremities; occasional twitching of face; puts tongue out

when spoken to; takes a little milk with a spoon; keeps muttering a good deal; constant vigil; passes urine involuntarily; bowels constipated lately. Dr. Lancaster found "no neuritis or other abnormality of fundus."

Thirteenth day. Patient's condition is decidedly worse. There is now profound unconsciousness, with less convulsive movements of hands; respiration rapid; temperature between 101 and 103; pulse weak and rapid; takes very little nourishment; loose movements of bowels to-night after repeated cathartics.

Fourteenth day. Patient failed steadily all day. The pulse grew weaker and weaker, and the respiration became more shallow, until he died at 11.55 P.M.

Autopsy: Brain: pia extremely distended by a large amount of slightly thickened, cloudy, serous fluid. The brain looked as if covered with a thick layer of wine jelly. Vessels of pia markedly injected. The right lateral ventricle had noticeable adhesions between opposite layers of the ependyma; velum interpositum thickened and contracted; no œdema of any organs of the body; other organs, with the exception of emphysema of lungs, negative.

Under the title of "A Case of Recurrent Basilar Meningitis," Dr. Henry M. Koles reports[1] a case which undoubtedly was of the serous variety, with effusion into the ventricles. The patient, 23 years old, had previously suffered from several (four) similar attacks of varying, but, as compared with the last attack, less severity. The first followed a boxing bout, when he was thrown against the edge of a table and rendered unconscious. In one attack there was paralysis of one arm and leg. At one period he suffered from attacks of headache, recurring every six months, preceded by vomiting, and confining him in bed for several weeks at a time.

Final attack: Onset, sudden; vomiting, headache, restlessness; fever (T., 101), rapid full pulse. Recovery in the course of a few days; return to business followed after a few hours of the same day by sudden faintness, dizziness, and nausea; severe vomiting. Again fever, rapid pulse,

[1] Med. Rec., Oct. 10, 1896.

flushed and anxious face, labored breathing; retraction of the head. During following ten days progressively worse, various paralytic symptoms developing one after another. Symptoms: pain in head, abdomen, and back of neck, and rigidity of muscles of neck. Dilated and stable pupils, exophthalmos, then ptosis and double sixth-nerve paralysis. Neck rigid and immovable. Increased pain in head, and pain down the arm. Restlessness and delirium; maniacal. Left facial paralysis. Highest temperature, 103; pulse, 140. Optic neuritis. Apathetic and delirious by turns. Cheyne-Stoke respiration. Death apparently impending, but instead unexpected gradual improvement and recovery. Treatment anti-syphilitic, though no history of syphilis.

The exophthalmos, double sixth-nerve paralysis, and dilated pupils are plainly indicative of increased pressure from effusion into the ventricles.

XI.

A STUDY OF THE BLOOD IN RICKETS.

By John Lovett Morse, A.M., M.D.

The blood of infants under two years differs in certain of its characteristics from that of adults. The number of red corpuscles is about the same or a little larger, averaging a little over 5,000,000 per cubic millimetre. The number of white corpuscles per cubic millimetre is somewhat larger, averaging from 10,000 to 12,000. The relative proportions of the various forms of leucocytes are also considerably different. The limits, as given by Gundobin, are as follows:

Small Mononuclear . . .	50%–70%
Large Mononuclear . . .	6%–14%
Polynuclear Neutrophiles . .	28%–40%
Eosinophiles	1%–10%

That is, the proportion of mononuclear, or unripe, forms is about three times as great as in adult life, while that of the polynuclear neutrophiles, or over-ripe, form is only half as large. The mononuclear cells, moreover, are not merely lymphocytes, but vary much not only in the size of the cell as a whole, but also in the size of the nucleus and in the amount of protoplasm. Finally, an increase in the number of eosinophilic cells, even if considerable, seems to be of less significance.

Anæmia of various sorts is very common in children. It develops more easily and more frequently as the result of various morbid conditions and diseases in them than in adults. This is because the tissue changes in them are more rapid, as the old tissues have not only to be nourished and replaced, but new ones formed. Hence any disturbance

of nutrition is more serious and results in more rapid and significant changes in the blood.

The classification of the anæmias of children is at best a vexed one. That of Monti is the most complete, but seems unnecessarily complicated. They, as those of adults, may be roughly divided into the primary and secondary, the primary being subdivided into simple anæmia, chlorosis, and pernicious anæmia. Chlorosis with its typical symptom complex and blood is not a disease of early childhood. Warner, however, has noted that "in the simple anæmias of childhood the percentage of hæmoglobin is diminished to a much greater extent than that of the red globules." I have also noted this in the anæmia secondary to various diseases. Although cases of the so-called progressive pernicious anæmia have been reported in young children, they are all open to criticism, and it is very doubtful if the condition occurs in them. The simple and secondary anæmias may be divided into the mild and severe forms (anæmia levis and anæmia gravis). In the former the diminution in the specific gravity, hæmoglobin, and number of erythrocytes is slight, and the red corpuscles show no histological changes. In the latter the diminution in the specific gravity, hæmoglobin, and number of red corpuscles is marked, and the histological changes in the red cells are often considerable. The differences, however, are merely in degree, and only show a greater or less amount of disturbance of the blood-forming organs. Either may or may not be accompanied by leucocytosis. In all but the mild anæmia without leucocytosis the spleen may be enlarged. It is to these cases that the term "splenic anæmia" has been applied. They do not merit a special name, however, as there is nothing characteristic in the blood condition, and an enlarged spleen may be associated with a normal condition of the blood.

Much confusion exists concerning the so-called anæmia infantum pseudo-leukæmica. The description of this blood condition, as given by Luzet and Alt and Weiss, is as follows: Constant diminution in number of erythrocytes; constant more or less marked diminution in hæmoglobin; poikilocytosis; very many nucleated red cells, mostly of

abnormal form and many showing karyokinetic figures; polychromatophilia of the nucleated red cells and of many of the non-nucleated: pretty marked leucocytosis, always polymorphous. In addition there is always splenic tumor and more or less enlargement of the liver. Those who consider this blood condition characteristic are divided as to the limitations of the disease. Some, who consider it always primary, would rule out those cases in which it develops secondary to rickets, syphilis, or other anæmias, while others would include them. Others think that there is nothing characteristic in the blood condition, but that it is merely a very severe anæmia, and not typical of any disease. Fischl has found the same type of blood in cases of rickets both with and without splenic enlargement. Moreover, cases of progressive anæmia with enlarged liver and spleen do not always show this condition of the blood. Whether the condition known as anæmia infantum pseudo-leukæmica is to be considered as a separate disease or as merely a severe form of anæmia gravis with leucocytosis must therefore be left for the future to determine.

It is generally recognized that leucocytosis develops more quickly and to a higher degree in children than in adults. While in adults the increase of white cells is almost entirely in the polynuclear neutrophiles, this is not the case in children. In them the leucocytosis is sometimes due to the increase of lymphocytes, sometimes to that of the large mononuclear forms, sometimes to that of the polynuclear neutrophiles, and sometimes even to that of the eosinophiles. According to Weiss, the lymphocytes are much increased proportionately in affections of the gastro-enteric tract, while the mononuclear cells of all sorts, as well as the transition forms, are proportionately increased in those of the respiratory tract. When there are complicated tissue changes and severe organic disturbances, the proportions of the various forms of leucocytes show wide variations. He concludes that the proportions of the leucocytes correspond to certain tissue conditions and alterations, and are thus characteristic for certain diseases only in so far as quite definite tissue changes occur in these diseases. As the same pathological changes occur in many diseases, and different ones in the

same disease, it is evident that the same histological blood condition is not always to be found in the same disease.

Monti has found that in normal children there is a constant relation between the specific gravity of the blood and the amount of hæmoglobin. They vary directly. This relation is not constant in disease, however, and may vary in various ways.

Although the blood must have been examined in many cases of rickets, the literature of the subject is very meagre. No work worthy of mention seems to have been done in this direction before the beginning of the present decade. Since then, however, several observers have reported short series of cases, although no one seems to have undertaken a systematic investigation of the subject.

Monti found all the forms of anæmia described by him in his classification in rhachitis. As a rule, he found the more severe forms in the severe cases. No definite connection between the clinical course of the cases and the condition of the blood could be made out, however. A greater proportion of the severe than of the mild forms showed splenic tumor. A greater proportion of the cases with splenic tumor showed leucocytosis than did those without. Certain cases with very large spleens showed no leucocytosis, however, and others without splenic enlargement showed a high grade. He concludes that "rickets as such does not cause any peculiar anæmia, but that according to the severity of the rhachitic process and the associated involvement of the blood-forming organs very different forms and gradations of chronic anæmia may occur."

Felsenthal examined the blood in 12 cases of rhachitis between the ages of 9 months and 2 years, 9 of which were mild cases with little or no enlargement of the spleen, while 3 were severe and had large, hard spleens. He obtained the same results in all. The number of red corpuscles was normal or almost normal, and there was no evident relation between the number of corpuscles and the severity of the case. The hæmoglobin was diminished in all cases, and always to a greater extent than the red corpuscles. The number of white corpuscles was always increased. He considered the oligochromæmia as the most striking feature.

He found that the red corpuscles often showed a considerable variation in size, and that nucleated forms, mostly normoblasts, and never very numerous, occurred in the severe cases. The majority of the white corpuscles were small and large mononuclear.

Weiss examined the blood in 6 cases. He found that all cases of severe rhachitis show a typical leucocytosis, the principal part of which is to be attributed to an increase of the mononuclear cells. The transition forms are also numerous, so that the polynuclear cells appear relatively diminished.

Gundobin found the same condition in the blood of rickets as in that of other forms of retarded development. He concludes that rickets as rickets causes no peculiar pathological change in white cells, and that any change in them is dependent on concurrent involvement of the internal organs.

Luzet thinks that the blood in rickets associated with splenic enlargement may show all stages from mild anæmia to leukæmia. He thinks the splenic tumor causes leucocytosis, increases the anæmia, and makes the prognosis more gloomy.

Rotch reports the results of the examination of the blood in two cases of rhachitic anæmia, one without and one with splenic tumor. The diminution of red corpuscles and of hæmoglobin was more marked in the latter. It showed no leucocytosis, however, while the former did.

Hock and Schlesinger have found that the specific gravity of the blood in rickets is entirely independent of the severity of the rhachitic process, but varies with the anæmia. Felsenthal and Bernhard have also shown that it varies with the amount of hæmoglobin.

I have examined the blood in twenty cases of active, uncomplicated rickets in infants under two years of age. The blood was in every case taken from the lobe of the ear, and examined with a Thoma-Zeiss apparatus. It was diluted (1–200) with a 3 per cent. salt solution colored with methylene blue. The red corpuscles in one-tenth of a cubic millimetre and the white corpuscles in two cubic millimetres were counted. The hæmoglobin was estimated with a von

Fleischl instrument. Cover-slips were in all cases made at the same time, hardened in equal parts of alcohol and ether, and stained with Ehrlich's "triple stain." A differential count of at least 500 white corpuscles was then made, the classification recommended by Ehrlich being used. As far as possible the blood was taken about noon, and in most cases about three hours after food. The cases may be roughly divided into three groups according to the severity of the process: those in which the manifestations are mild; those in which they are more severe, but in which there is no splenic enlargement; and those in which there is splenic tumor. The first group comprises 9 cases; the second, 4; and the third, 7. The data of the individual cases are as follows:

MILD CASES.

I. Male. Negro. Eight months.

Breast for six weeks. Mellin's food since.

Marked sweating of head for two months. Always little cough. Bowels usually regular.

W. D. and N. Flabby. Holds up head. Head of good shape. Anterior fontanelle widely open. No teeth. Sits alone feebly with marked kyphosis of weakness. Moderate rosary. Moderate retraction of ribs at diaphragm with flaring below. Heart and lungs normal. Abdomen large but soft. Liver normal. Spleen not palpable. No enlargement of epiphyses. No glandular enlargement.

Hæmoglobin	60%
Red Corpuscles	4,170,000
White Corpuscles	9,600
Small Mononuclear	34%
Large Mononuclear	4%
Polynuclear Neutrophiles	61%
Eosinophiles	1%

No irregularity in size or form of red corpuscles.

II. Female. Irish. Seven months.

Breast for three months. Then Horlick's malted milk.

Head sweats. Restless at night. Tendency to diarrhœa.

F. D. and N. Flabby. Pale. Holds up head. Head normal. No teeth. Sits alone feebly with moderate kyphosis of weakness. Moderate rosary. Heart and lungs normal. Abdomen full and soft. Liver and spleen normal. Slight enlargement of epiphyses at wrists. Slight general glandular enlargement.

Hæmoglobin	57%
Red Corpuscles	4,200,000
White Corpuscles	9,300
Small Mononuclear	36%
Large Mononuclear	3%
Polynuclear Neutrophiles	60%
Eosinophiles	1%

No irregularity in size or shape of red corpuscles.

III. Female. Negro. Seven months.

Breast for five months. Condensed milk since.

Head sweats. Rolls head. Kicks off clothes. Vomits occasionally.

Large, fat child. Head normal. No teeth. Sits alone with fairly straight back. Slight rosary. Heart and lungs normal. Abdomen little full and tense. Liver and spleen normal. Slight enlargement of epiphyses at wrists. Little bowing of tibiæ. Slight general glandular enlargement.

Hæmoglobin	60%
Red Corpuscles	5,048,000
White Corpuscles	14,770
Small Mononuclear	61%
Large Mononuclear	4%
Polynuclear Neutrophiles	33%
Eosinophiles	2%

Moderate variation in size of red corpuscles, many being large. No poikilocytosis. One normoblast seen in two slides. Several of the large mononuclear leucocytes very large and containing a very large nucleus.

IV. Male. Irish. Thirteen months.

Breast for ten months. Now arrow-root and milk.

Pertussis at seven months. Sits, creeps, and stands alone.

W. D. and N. Flabby. Pale. Head a little large. Fontanelle normal. Six teeth. General kyphosis of weakness. Moderate rosary. Heart and lungs normal. Abdomen soft and not distended. Liver and spleen normal. Considerable enlargement of epiphyses at wrists. No glandular enlargement.

Hæmoglobin	67%
Red Corpuscles	4,936,000
White Corpuscles	18,800
Small Mononuclear	24%
Large Mononuclear	14%
Polynuclear Neutrophiles	58%
Eosinophiles	4%

V. Female. Negro. Thirteen months.

Breast off and on. Mellin's food for eight months. Then milk. Also a little "table food."

Never well. Very fussy. Head sweats a good deal. Cannot creep or stand.

W. D. and N. Flesh firm. Head rather large, but of fair shape. Fontanelle three-quarters of an inch square. No teeth. Sits almost straight. Moderate rosary. Heart and lungs normal. Abdomen large and rather tense. Large umbilical hernia. Liver and spleen not enlarged. Moderate enlargement of epiphyses at wrists. Slight knock-knee. Some general glandular enlargement.

Hæmoglobin	48%
Red Corpuscles	5,024,000
White Corpuscles	17,900
Small Mononuclear	47%
Large Mononuclear	8%
Polynuclear Neutrophiles	44%
Eosinophiles	1%

Very slight variation in size and shape of red corpuscles.

VI. Male. Irish. Twenty-two months.

Still on breast. General diet since fourteen months.

Always well. Does not stand.

F. D. and N. Flabby. Pale. Frontal and parietal eminences large. Fontanelle one-half inch square. Ten teeth. Sits with fairly straight back. Marked rosary. Slight retraction at diaphragm. Heart and lungs normal. Abdomen, liver, and spleen not enlarged. Cannot stand. Epiphyses at wrists and ankles much enlarged. Anterior bowing of femora and outward of tibiæ. No glandular enlargement.

Hæmoglobin	70%
Red Corpuscles	5,144,000
White Corpuscles	10,700
Small Mononuclear	52%
Large Mononuclear	4%
Polynuclear Neutrophiles	42%
Eosinophiles	2%

No variation in size or shape of red corpuscles.

VII. Male. Negro. Seventeen months.

Still on breast. General diet since twelve months.

Always fairly well. Head sweats. Fussy.

F. D. and N. Flabby. Head rather large. Fontanelle nearly closed. Six teeth. Sits fairly straight. Moderate rosary. Heart and lungs normal. Abdomen rather large, but soft. Small umbilical hernia. Liver and spleen normal. Cannot stand. Epiphyses at wrists large. Slight bowing of tibiæ. Slight general glandular enlargement.

Hæmoglobin	64%
Red Corpuscles	5,102,000
White Corpuscles	14,000
Small Mononuclear	49%
Large Mononuclear	6%
Polynuclear Neutrophiles	43%
Eosinophiles	2%

No variation in size or shape of red corpuscles.

VIII. Female. Negro. Eight months.

Condensed milk, one month; cow's milk, three months; malted milk, four months.

Head sweats a great deal. Sleeps poorly. Diarrhœa for long time.

F. D. and N. Rather flabby. Head normal. No teeth. Cannot sit alone. Moderate rosary. Heart and lungs normal. Abdomen not enlarged. Liver and spleen normal. Epiphyses at wrists enlarged. Tendency to knock-knee. No glandular enlargement.

Hæmoglobin	67%
Red Corpuscles	4,840,000
White Corpuscles	10,200
Small Mononuclear	53%
Large Mononuclear	4%
Polynuclear Neutrophiles	41%
Eosinophiles	2%

A very little variation in size, but none in shape of red corpuscles.

IX. Male. Negro. Fourteen months.

Never nursed. Oatmeal and milk. Then general diet.

Head sweats. Restless at night. Always little cough. Constipation. Weak. Tries to stand.

F. D. and N. Head large, flat on top. Anterior fontanelle not widely open. Two teeth. Back straight. Marked rosary. Sternum prominent. Marked drawing-in at diaphragm. Heart and lungs normal. Abdomen large and soft. Liver and spleen normal. Epiphyses at wrists considerably enlarged. Knock-knee. No glandular enlargement.

Hæmoglobin	62%
Red Corpuscles	5,528,000
White Corpuscles	9,000
Small Mononuclear	32%
Large Mononuclear	16%
Polynuclear Neutrophiles	51%
Eosinophiles	1%

A good deal of variation in the size of red corpuscles. Numerous microcytes and macrocytes. Moderate poikilocytosis. Numerous very large mononuclear cells with large pale nucleus and wide pale protoplasm.

SEVERE CASES.

X. Female. Irish. Six months.

P. D. and N. Pale. Craniotabes. Moderate rosary. Heart and lungs normal. Abdomen large and soft. Liver extends 4 centimetres below costal border. Spleen not palpable. Epiphyses at wrists large. No glandular enlargement.

Hæmoglobin	65%
Red Corpuscles	4,704,000
White Corpuscles	13,800
Small Mononuclear	48%
Large Mononuclear	4%
Polynuclear Neutrophiles	48%
Eosinophiles	0%

Moderate variation in size of red corpuscles. Slight poikilocytosis.

XI. Male. Italian. Two months.

Condensed milk.

Small and emaciated. Skin dry. Pale. Sutures open and bones movable. Slight rosary and retraction at diaphragm. Heart and lungs normal. Abdomen soft. Liver and spleen normal. No enlargement of epiphyses. No glandular enlargement.

Hæmoglobin	52%
Red Corpuscles	3,508,000
White Corpuscles	9,200
Small Mononuclear	69%
Large Mononuclear	5%
Polynuclear Neutrophiles	25%
Eosinophiles	1%

Marked variation in size of red corpuscles. Macrocytes much more numerous than microcytes. Marked poikilocytosis. Three macroblasts and two normoblasts seen in counting 500 whites.

XII. Male. Italian. Nineteen months.

Breast for a year. General diet since.

Sweats a good deal. Diarrhœa for a month. Quiet. Sits alone. Cannot creep or stand.

P. D. and N. Much hair. Pale. Head rather large, but not abnormal in shape. Anterior fontanelle open, one-half inch in each diameter. Four teeth. Marked general kyphosis, not disappearing on suspension. Marked rosary. Heart and lungs normal. Abdomen very large, tense, and tympanitic. Liver and spleen normal. Epiphyses at wrists large. Large glands in groins only.

Hæmoglobin	67%
Red Corpuscles	5,296,000
White Corpuscles . . .	7,200
Small Mononuclear . . .	29%
Large Mononuclear . . .	17%
Polynuclear Neutrophiles . .	53%
Eosinophiles	1%

Slight variation in size of red corpuscles. Occasional microcyte and macrocyte. A very little poikilocytosis. Numerous very large mononuclear white cells.

XIII. Male. Negro. Two years.

Brought for "general weakness." Head sweats. Tendency to looseness of bowels. Sits alone. Cannot creep or stand.

P. D. and emaciated. Head large and forehead square. Anterior fontanelle open, an inch in each diameter. Ten teeth. General kyphosis of weakness. Pigeon breast. Marked rosary. Slight retraction of chest at diaphragm. Heart and lungs normal. Very large abdomen.

Umbilical hernia. Liver and spleen normal. Epiphyses at wrists large. Inguinal glands enlarged, others not.

Hæmoglobin	64%
Red Corpuscles	4,604,000
White Corpuscles	5,500
Small Mononuclear	39%
Large Mononuclear	15%
Polynuclear Neutrophiles	45%
Eosinophiles	1%

Very little variation in size and none in shape of red corpuscles.

CASES WITH SPLENIC TUMOR.

XIV. Female. Irish. Nine months.

Breast and general diet.

Constipation. Losing weight. Restless at night. Kicks off clothes.

Head sweats. Sits alone.

F. D. and N. Flabby. Rather pale. Parietal eminences very large, frontal somewhat so. Fontanelle almost closed. No teeth. Sits straight. Slight rosary. Heart and lungs normal. Abdomen little full. Liver extends an inch below costal border. Spleen just palpable. Epiphyses at wrists a little large. No glandular enlargement.

Hæmoglobin	77%
Red Corpuscles	4,724,000
White Corpuscles	22,000
Small Mononuclear	63%
Large Mononuclear	4%
Polynuclear Neutrophiles	31%
Eosinophiles	2%

A little variation in size and shape of red corpuscles.

XV. Male. Norwegian. Twenty months.

Always cow's milk. Now fair diet.

Measles at one year. Very few digestive symptoms. Constipation. Sat up at nine months. Just beginning to creep. Doesn't stand. Brought because he cries when stood on feet. Not tender to touch.

F. D. and N. Flabby. Pale. Large head. Fontanelle widely open. Sixteen teeth. Sits with marked kyphosis in lower dorsal region, which is only partially obliterated on suspension. Small chest. Marked rosary. Heart and lungs normal. Abdomen large and soft. Liver large. Spleen palpable. Epiphyses enlarged at wrists and ankles. Anterior and lateral bow-legs. General glandular enlargement.

Hæmoglobin	73%
Red Corpuscles	4,448,000
White Corpuscles	14,400
Small Mononuclear	49%
Large Mononuclear	6%
Polynuclear Neutrophiles	40%
Eosinophiles	5%

Moderate variation in size of red corpuscles, but no microcytes or macrocytes. Very little poikilocytosis.

XIV. Male. Italian. Nine months.

Breast and general diet.

Measles and diphtheria at six months, followed by running ear. Subject to attacks of vomiting and diarrhœa. Head sweats badly. Sits alone.

F. D. and N. Flabby. Pale. Large square head. Fontanelle very widely open, but not tense. No teeth. Back straight. Small chest. Marked rosary. Heart and lungs normal. Abdomen large and tense. Liver normal. Spleen palpable. Epiphyses at wrists and ankles enlarged. No glandular enlargement.

Hæmoglobin	60%
Red Corpuscles	4,068,000
White Corpuscles	14,500
Small Mononuclear	34%
Large Mononuclear	3%
Polynuclear Neutrophiles	56%
Eosinophiles	7%

No variation in size or shape of red corpuscles.

XVII. Female. Irish. Fifteen months.

Now on milk and cracker only.

Brought because of "weakness in legs." Sits alone. Doesn't creep.

F. D. and N. Pale. Head a little large. Fontanelle almost closed. Seven teeth. Back straight. Marked rosary. Heart and lungs normal. Abdomen full. Liver normal. Spleen distinctly palpable. Large epiphyses at wrists. Legs held loosely and rotated outward at hips. Tendency to talipes varus. No spasm. Knee-jerks present and equal. No glandular enlargement.

Hæmoglobin	64%
Red Corpuscles . . .	4,936,000
White Corpuscles . . .	11,900
Small Mononuclear . . .	39%
Large Mononuclear . . .	6%
Polynuclear Neutrophiles . .	48%
Eosinophiles	7%

Moderate variation in size of red corpuscles. A few macrocytes and numerous microcytes. Slight poikilocytosis.

XVIII. Male. Irish. Five months.

Never gained. Cries constantly. Sleeps very little. Frequent vomiting. Constipation.

Small, but not much emaciated. Marked pallor. Head negative; can hold it up. Cannot sit alone. Marked rosary. Systolic murmur over whole præcordia. Heart otherwise normal. A few râles here and there in both chests. Abdomen lax. Liver normal. Spleen palpable below costal border, as large as last phalanx of thumb. Epiphyses at wrists slightly enlarged. No glandular enlargement.

Hæmoglobin	57%
Red Corpuscles . . .	4,519,000
White Corpuscles . . .	15,900
Small Mononuclear . . .	44%

Large Mononuclear . . .	4%
Polynuclear Neutrophiles . .	47%
Eosinophiles	5%

A very little variation in size and shape of red corpuscles. One normoblast seen in counting five hundred white corpuscles.

XIX. Female. Russian. Twenty months.

Breast and patent foods at first. Now general diet. Always digestive disturbances. Very restless at night. Sits and stands; cannot walk.

F. D. and N. Flabby. Pale. Large, square, flat head. Anterior fontanelle nearly closed. Eleven teeth. General kyphosis of weakness. Pigeon breast. Marked retraction at diaphragm. Very marked rosary. Heart and lungs normal. Abdomen large and soft. Liver not enlarged. Spleen palpable below costal border, seven centimetres laterally and three centimetres vertically. Marked enlargement of epiphyses at wrists. Moderate bowing of both femora and tibiæ. No glandular enlargement.

Hæmoglobin	68%
Red Corpuscles	5,518,000
White Corpuscles . . .	15,200
Small Mononuclear . . .	51%
Large Mononuclear . . .	5%
Polynuclear Neutrophiles . .	40%
Eosinophiles	4%

Considerable variation in size of red corpuscles. Numerous macrocytes. Moderate poikilocytosis. Occasional normoblasts.

XX. Female. Irish. Seventeen months.

Condensed milk and barley-water.

Pale for a long time. Rapid loss of flesh in last three months.

Tumor in abdomen noted two months ago, as large then as now. Just beginning to sit up alone. No vomiting. Constipation.

F. D. and emaciated. Marked pallor with yellowish tinge. Fontanelle not closed. Four teeth. Rosary. Heart and lungs normal. Abdomen very full and tense. Umbilical hernia. Liver not enlarged. Spleen fills left half of abdomen, reaching nearly to median line and to within half an inch of anterior superior spine. No ascites. Epiphyses enlarged. No glandular enlargement. Purpuric spots on abdomen. Urine negative.

Hæmoglobin	60%
Red Corpuscles	3,556,000
White Corpuscles . . .	12,400
Small Mononuclear . . .	28%
Large Mononuclear . . .	10%
Polynuclear Neutrophiles . .	55%
Eosinophiles	7%

Marked variation in size of red corpuscles. Many macrocytes and microcytes, the former being the more numerous. Moderate poikilocytosis. Moderate number of nucleated red corpuscles, megaloblasts being the most common form. Occasionally free nuclei. No abnormal forms of white corpuscles.

The results of the blood examinations are more evident, perhaps, in the following table:

No.	Age in Months.	Type of Disease.	Hæmoglobin.	Erythrocytes.	Leucocytes.	Small Mononuclear.	Large Mononuclear.	Polynuclear Neutrophiles.	Eosinophiles.	Morphology of Erythrocytes.
1 . .	8	mild	60%	4,170,000	9,600	34%	4%	61%	1%	Normal.
2 . .	7	"	57%	4,200,000	9,300	36%	3%	60%	1%	Normal.
3 . .	7	"	60%	5,048,000	14,770	61%	4%	33%	2%	Moderate variation in size. Normoblasts.
4 . .	13	"	67%	4,936,000	18,800	24%	14%	58%	4%	Nearly normal.
5 . .	13	"	48%	5,024,000	17,900	47%	8%	44%	1%	Nearly normal.
6 . .	22	"	70%	5,144,000	10,700	52%	4%	42%	2%	Normal.
7 . .	17	"	64%	5,102,000	14,000	49%	6%	43%	2%	Normal.
8 . .	8	"	67%	4,840,000	10,200	53%	4%	41%	2%	Slight variation in size.
9 . .	14	"	62%	5,528,000	9,000	32%	16%	51%	1%	Considerable variation in size. Moderate poikilocytosis.
10 .	6	severe	65%	4,704,000	13,900	48%	4%	48%	0%	Moderate variation in size. Slight poikilocytosis.
11 .	2	"	52%	3,508,000	9,200	69%	5%	25%	1%	Marked variation in size. Marked poikilocytosis. Macroblasts and normoblasts.
12 .	19	"	67%	5,290,000	7,200	29%	17%	53%	1%	Slight variation in size. Slight poikilocytosis.
13 .	24	"	64%	4,604,000	5,500	39%	15%	45%	1%	Nearly normal.
14 .	9	spleen palpable	77%	4,724,000	22,000	63%	4%	31%	2%	Nearly normal.
15 .	20	"	73%	4,448,000	14,400	49%	6%	40%	5%	Moderate variation in size. Slight poikilocytosis.
16 .	9	"	60%	4,068,000	14,500	34%	3%	56%	7%	Normal.
17 .	15	"	64%	4,936,000	11,900	39%	6%	48%	7%	Moderate variation in size. Slight poikilocytosis.
18 .	5	spleen considerably enlarged	57%	4,519,000	15,900	44%	4%	47%	5%	Slight variation in size. Slight variation in shape. Rarely a normoblast.
19 .	20	"	68%	5,158,000	15,200	51%	5%	40%	4%	Considerable variation in size. Moderate poikilocytosis. Occasional normoblast.
20 .	17	spleen very large	60%	3,556,000	12,400	28%	10%	55%	7%	Marked variation in size. Moderate poikilocytosis. Numerous nucleated forms.

An analysis of these cases shows that the number of red corpuscles was in all cases normal or but slightly diminished; that the percentage of hæmoglobin was always diminished, and always proportionately more so than that of the red corpuscles: that there was a leucocytosis in a little more than half the cases; that this leucocytosis occurred more frequently in those cases with splenic tumor than in those without: that the amount of the leucocytosis was independent of the presence, or absence, or size of the splenic tumor; and that the histological changes in the red corpuscles increased, as a rule, with the severity of the case, being most marked in those with splenic tumor.

The approximately normal number of red corpuscles and the absolutely and relatively diminished proportion of hæmoglobin agrees with the results obtained by Felsenthal. It must be remembered, however, as has already been noted, that this condition is not an uncommon one in the anæmias of childhood.

The results as regards the white corpuscles do not agree with those of Felsenthal, who found a leucocytosis in every case, but rather corroborate Monti's conclusions that leucocytosis may or may not be present, and that it is more frequent in the cases with splenic tumor. They also confirm his observation that certain cases with very large spleens have no leucocytosis, as the case with the largest spleen had but little more than the normal number of white corpuscles. The average of the different forms of leucocytes in the nine cases without leucocytosis gives the following proportions, which are somewhat different from those given by Gundobin for normal blood:

Small Mononuclear . . .	43%
Large Mononuclear . . .	8%
Polynuclear Neutrophiles . .	47%
Eosinophiles	2%

The average proportions in the eleven cases with leucocytosis, as well as in the six cases with enlarged spleens, are:

Small Mononuclear . . .	45%
Large Mononuclear . . .	5%–6%
Polynuclear Neutrophiles . .	45%
Eosinophiles	4%–5%

That is, almost the same as in the cases without leucocytosis.

These results do not agree with those of Weiss and Felsenthal, who found the increase in the mononuclear and transition forms, but rather with Weiss's general statement that when there are complicated tissue changes the increase may be in any or all of the different forms of leucocytes. It is noticeable that eosinophilic cells are considerably more numerous in the cases with splenic tumor. The association of nucleated forms and of variations in the size and shape of the red corpuscles with an almost undiminished number is of interest.

Conclusions. — The results obtained in these cases, together with those obtained by others, seem to justify the following conclusions: Most cases of rickets are accompanied by anæmia. This anæmia may be of any form and of any grade of severity. The severity of the anæmia varies in a general way with the severity of the process. The most common form is that in which the number of red corpuscles is normal or nearly normal, and the percentage of hæmoglobin both absolutely and relatively diminished. The anæmia may or may not be accompanied by leucocytosis. Leucocytosis occurs more frequently in the cases with splenic tumor than in those without. It may be due to an increase in any or all of the varieties of white corpuscles. The specific gravity varies with the amount of hæmoglobin. Finally, there is no form of anæmia found in rickets which may not be found in other conditions, and no form of anæmia found in other conditions which may not be found in rickets.

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XII.

THE BOSTON CITY HOSPITAL MEDICAL SOCIETY.

By Abner Post, M.D., and A. S. Knight, M.D.

In the hospital report for 1895 was given a short account of the Hospital Medical Society, describing its character and its meetings. The society continued its existence during 1896, meeting monthly from January until May and resuming its meetings in November.

The same general plan has been followed of presenting cases and specimens and limiting remarks and discussion to the description necessary for an understanding of their peculiarities, and in addition the more or less informal presentation of such matters as were of special value to the staff.

The attendance has shown a continued interest. There were present in

January	54
February	49
March	60
April	49
May	42
November	73
December	70

— an average attendance of 56.5.

The percentage of former internes of the hospital present at these meetings has been large, though no statistics of their numbers have been kept.

Our hospital has always done a large amount of clinical teaching, and at the present time more teaching is done than ever before. But the influence of a hospital in the matter of medical education ought not to be confined to teaching students. It ought to extend to the more adult portion of

the medical community, and it is a source of pride that these meetings have utilized to some extent the valuable material for the advantage of its former house-officers. The cases have been of unusual character: some of them have been unique. They have illustrated a very wide range of pathology, as will be seen by any one who is sufficiently interested to read the appended lists.

The order of exercises of each meeting is given, and will serve to illustrate not merely the characteristics of the meetings, but will also serve as an index to the wide range of cases seen in this hospital.

There were shown at the meeting on January 9, 1896:

1. A case after colotomy for intestinal obstruction.

2. Result of skin-grafting by Thiersch's method in a case in which the skin had been torn from base of fingers to elbow. Dr. Councilman recalled certain experiments on skin-grafting which prove that the pigment is formed below and not in the epithelium.

3. Inguinal hernia four years after operation by McBurney's method. Cicatrix broken down and hernia again presenting.

4. Lupus of nose, for which it was proposed to use tuberculin injections. Dr. Councilman described the four distinct forms of tuberculosis of the skin. Drs. Gage and Harding told of cases not permanently improved by tuberculin treatment.

5. Dr. Nichols described the cause, morbid anatomy, course, and treatment in three types of acute osteomyelitis, as illustrated by specimens from the wards.

6. Dr. Councilman demonstrated a case of acute, general disseminated miliary tuberculosis, which started from a tuberculous aneurism of aorta.

FEBRUARY 13.

1. Double castration for enlarged prostate.
2. Leukæmia with enlarged spleen.
3. Congenital deformities of the fingers and feet.

4. The same little girl with lupus of nose who was exhibited in January. No improvement had followed the use of tuberculin, but curetting had brought about cicatrization.

5. Gonorrhœal rheumatism of wrist.

6. Excision of knee.

7. Echinococcus of liver with pneumococcus infection.

8. Colotomy.

9. Dislocation of humerus reduced by manipulation eight months after the injury.

10. Anthrax of neck; the patient had recovered after excision of the disease. Water-color sketches and cultures made before the operation.

11. Skiagraph of Colles' fracture.

12. Photographs of an extraordinary ventral hernia following operation for appendicitis.

MARCH 12.

1. Large white kidney revealed by exploratory laparotomy.

2. Inward dislocation of ankle. Reduced only after resection of astragalus.

3. A patient after intra-pulmonary injections of tincture iodine and glycerine for tuberculosis of lung. No perceptible improvement.

4. Multiple periostitis of syphilitic origin.

5. Traumatic hysteria.

6. Dr. Curry described the results of animal inoculation with anthrax and citreus, from case of anthrax shown at former meeting.

7. Encapsulated empyæma, apparently recovering without radical operation.

8. Dr. H. W. Cushing described a case of extra-uterine gestation successfully operated upon.

9. Demonstration of a malignant endocarditis following first attack of rheumatism. Cultures showed many streptococci, and autopsy revealed acute ulcerative endocarditis and purulent pericarditis.

10. Cultures and sections from case of criminal abortion.

APRIL 9.

1. Tumor (or abscess) of brain.

2. Doubtful case of cerebral syphilis or of general paralysis in a child.

3. Syphilitic caries of skull.

4. Progressive pernicious anæmia.

5. Remarkably serviceable arm nine years after a compound fracture into the elbow-joint. Also a useful leg after one-half of the tibia had been crushed and removed.

6. Marked aortic regurgitation following three attacks of rheumatism.

7. Tuberculous ulcer on legs.

8. Hypertrophic cirrhosis with jaundice. Many subcutaneous hæmorrhages.

9. Benign enchondroma of testes.

10. Dr. Curry showed a hydro-nephrotic kidney caused by calculus, and another with a calculus in the pelvis.

11. Dr. Curry also reported results of autopsies on thirty-two cases of pneumonia. In every one pneumococci were found.

12. Dr. De Blois exhibited a large periwinkle shell which had been in a nose for eighteen years.

MAY 14.

1. Multiple transverse fractures of the patellæ.

2. Monarticular rheumatism.

3. Gangrenous appendix removed through $1\frac{7}{16}$-inch incision.

4. Extreme deformities of feet, as result of rheumatoid arthritis.

5. Skin-grafting on tuberculous ulcer of skin.

6. Man treated by drainage through perineum for supposed enlarged prostate. This gland was not enlarged, but the man had lost power to empty bladder without appreciable reason in either bladder or nervous system.

7. Chronic inflammatory tumor of groin, probably malignant.

8. Traumatic aneurism of the popliteal space.

9. Gall-stone of pure cholesterine from neck of gall-bladder. Also a salivary calculus.

10. Melanotic gall-bladder from case of multiple melanotic sarcoma.

11. Bladder and genitals showing how large calculus was propelled out of bladder and into good-sized pocket in urethra.

12. Large lipoma removed from sub-mammary region.

13. Dr. Rowe exhibited a lot of surgical instruments just received from Lüer.

NOVEMBER 12.

1. Extensive compound fracture of skull. Good recovery.

2. Depressed fracture of skull with extra-dural hæmorrhage.

3. Traumatic hæmato-nephrosis.

4. Patient after compound fracture: fractured end of humerus pierced deltoid so that operation was necessary.

5. Partial amputation of feet for frost-bites in Arctic regions, done by captain of a whaler with improvised instruments.

6. Anæsthesia and paraplegia relieved by laminectomy.

7. Return of cancer twelve years after tongue and lower jaw had been removed for same disease.

8. Gastrostomy by Witzel's method for carcinoma of lower end of œsophagus.

9. Dr. Councilman exhibited a carcinoma of stomach. The stomach wall was thickened, contracted, and enormously involved. Extension had been superficial — over peritoneal cavity, mesentery, intestine, and peritoneal surface of pelvis. No metastases.

10. Dr. F. H. Williams showed radiographs, and described methods and results of studying lung tissues by means of X-rays.

11. Drs. George B. Shattuck and Libby described serum test for typhoid, and gave results thus far obtained in hospital.

DECEMBER 10.

1. Patella fractured twice in same place.

2. Lupus of nose much improved after curetting and cauterizing.

3. Morphine habit, sixty grains a day subcutaneously. Skin showing results of multiple needle-punctures.

4. Gummata of testes.

5. Dr. Councilman showed a small cancer in wall of stomach, and large metastases into the lymphatic glands around pancreas and in the porta hepatica.

6. Ligature of innominate artery for aneurism.

7. Typhoid fever complicated with abscess of gall-bladder.

Certain friendly criticisms have been made, to the effect that the work of the society is superficial, and that no case is considered thoroughly: That there is insufficient opportunity to examine cases that require very careful examination, and that a diagnosis which seems made on insufficient grounds cannot be fully settled: That it interferes with the other societies of the city.

All of these objections have at least a basis of truth. Many of the cases are presented in outline, but many are given at some length, and sometimes the comments of the pathologist at a later meeting or a second exhibition of a patient completes a study that was at first very superficial.

It is intended to make these meetings as different as possible from the meetings of the older societies, and it is partly with that object that no papers are read and no reports of the meetings are published; so that the previous use of material at these meetings does not prevent the use of the same material as the basis of elaborate papers before other societies.

XIII.

A REMINISCENCE.

By David W. Cheever, M.D.

In June, 1864, after some delays, the Boston City Hospital was opened. Preparation had been made for surgical wards as well as for medical ones, for an operating theatre, a supply of instruments and general surgical appliances. The earlier surgery was largely accidental, such as fractures, compound fractures, crushes, cuts, amputations. Pathological surgery sought older hospitals. Of the six visiting surgeons first appointed, only one, besides the writer, served any considerable length of time. Indeed, up to 1869, five years after its opening, the Hospital had had one surgeon who served one year, two who served two years, one who served three years, and one four years.

Five-sixths of its surgical staff was gone in five years. This want of continuity of service was a great injury to the character of the surgical work. In addition to this evil, it is to be noted that most of its earlier surgical staff were physicians and surgeons, general practitioners of middle age and in full practice; and however much natural aptitude, good diagnostic powers, and unswerving devotion to work might aid them, still these gentlemen lacked long surgical training, and were harassed by a large family practice.

It is, then, very creditable to them that they struggled bravely to fight pyæmia and sepsis; and amid the terrible discouragement of those surgical days, so full of mortality, they never wavered in their daily visits and their honest efforts. Fractures of the skull, compound fractures of the limbs, resulted in a like percentage of fatalities, whether treated without or with trephining and amputation. Amputations, when primary, gave often a mortality of fifty

per cent. In abdominal operations, except hernia, more died than recovered: of pathological tracheotomy from 66 to 75 per cent. perished.

These are terrible figures: they are comparable only to war. And yet they were not exceptional, nor confined to any one hospital, thirty years ago. Suppuration was the rule; absorption, the risk; gangrene, the occasional consequence, of any injury. The pure air, the pure water, the pure soil of Hippocrates were remembered, and sought for, and fought for in hospital construction and administration. But the non-recognition of the invisible algæ and spores, which poison wounds by fermentation and multiplication in the blood, made all the difference between life and death. It is surprising how near to, and yet how far from, asepsis the surgeons of those days came. In the first professional report of the surgery of the Hospital, in 1869, we read, under "Compound Fractures," "Different forms of disinfectant dressing, particularly a thorough syringing of cavities and sinuses with a solution of permanganate of potash, half a grain to the ounce; or carbolic acid as a dressing, of a strength ranging from a drachm to the pint, up to equal parts with glycerine, were used with benefit. We do not think it yet time to decide on the asserted overwhelming merits of carbolic acid. While it was largely used, the Hospital was quite free from erysipelas and pyæmia for many months, but cases finally broke out while it was still employed. Again, longer periods of entire exemption from infectious diseases have occurred since, while other dressings were used."

It is a familiar memory to me also, that each patient was obliged to have his own sponge.

Débridement of ragged wounds in fasciæ; removing torn tissue; smoothing off sharp angles of bone, were all practised, and an attempt was made to seal the compound fracture in its blood. The pus cell was deterred by permanganate; the staphylococcus discouraged by carbolic; yet for want of preliminary shaving, scrubbing, corrosive, etc., to both limb, wound, instruments, and hands, and for want of sterile dressings, these excellent measures did not go far

enough for asepsis. Pus formed and burrowed; sloughing and necrosis followed. This table gives the results:

Compound fractures, lower extremity, for five years:

Recovered, 32; died, 49.

Ratio of mortality, 60 per cent.; expectant treatment, mortality 68 per cent.

Ratio of amputation, 58 per cent.; mortality after amputation, nearly 50 per cent. (47 amputated, 22 died).

Again, take trephining of twelve fractures of the vault: *not* trephined, mortality 59½ per cent.

Of ten fractures of the vault: *trephined*, mortality 60 per cent.

Of six fractures of the vault: elevated or sawed, mortality 66 per cent.

Hospital gangrene, the scourge of the army and sometimes of general hospitals, broke out for the first and only time in the Boston City Hospital, on Nov. 24, 1875; by December 30 it was conquered, and although a sporadic case appeared January 7, that soon subsided, and there were no more. There were eleven cases: ward D (an attic) furnished six cases; ward B (first story) five cases; ward C (female, second story), the story between B and D, escaped. By vacating B and D, cleaning, whitening, improving the drainage, and *letting in more air*, all trouble disappeared.

After the civil war various diseases, as chronic diarrhœa, typho-malarial fevers, general malaria, old suppurating wounds connected with bone, some erysipelas, and much debility and poor blood were brought to our Hospital by occasional applicants from the returning army.

This influence lasted for years. We do not mention this as an explanation of the gangrene, for bad air and infected wards, after ten years' occupancy, no doubt existed, and were a breeding-ground for any diseased condition. At this time the so-called contagious or isolating ward was much improved. The season forbade open-air treatment, but when summer came tents were used for three to four months for bad cases.

Surely the surgeons then toiling against this malign influence deserve credit for stamping it out in five or six

weeks; and the Hospital administration may be justly proud of its freedom from gangrene, as an epidemic, or *condition* of the wards, ever after. At that time all operations were abandoned; cases were isolated; bromine, first used in the army, was freely employed: also stimulants, tonics, and opium. Cleanliness, together with the vacating of the infected wards, soon cured the evil.

It may surprise the reader of to-day to see what cases were attacked:

(1.) A compound fracture.
(2.) An excoriation.
(3.) An old stump.
(4.) An acute abscess, incised.
(5.) An old sinus.
(6.) A simple fracture treated with leeches.
(7.) A bubo.
(8.) A simple fracture and contusion.
(9.) An incised wound.
(10–11.) Two fractures made compound by delirium tremens, and followed by amputation, gangrene, and death.

Eleven cases, six deaths.

In ward B, I had long had an aversion to one bed, in the right-hand corner on entering. I thought cases did badly there. It was found that a leaking drain communicated with the air in this corner by an air-shaft. This cause removed, its baneful effects vanished.

The first amputation of the thigh done in the Hospital united by first intention. No wound so large healed primarily, that I remember, until antisepsis was established.

Yet we had many good results, and a general mortality of from seven to nine per cent. only. Of thirty operations for the radical cure of hernia, where suppuration was the rule and was expected, all recovered but one.

The treatment and results of fractures were good. Ulcers healed, and we had many, in those days; but they did not do well until removed from a basement under ward B, long since disused.

Excisions of joints were in vogue, and did fairly.

Critical cases like œsophagotomy, displacement of the upper jaw, tumor of the tonsil, recovered.

In 1857, at Rainsford Island, I treated many cases of sloughing wounds and hospital gangrene sent down from Boston, and from its large hospitals, before the City Hospital was opened. I merely instance this to show the occasional, and not rare, occurrence of these results of suppuration in the best hospitals. These cases, removed to the sea air at Rainsford, and given plenty of such air, almost uniformly healed.

In those days pyæmia was the opprobrium of surgery and the dread of the surgeon. Erysipelas was common. Tetanus not more frequent than now, but when acute was fatal. Diphtheria was moderate in amount, but quite large in mortality. Alcoholism seemed to me more frequent than to-day. Syphilis and tuberculosis also seemed, if possible, more rife. The clinical thermometer was just being introduced; and the microscope was rather an anatomical toy than a surgical adjuvant.

The surgeon of that day fought a battle with disease, which kept him constantly at bay against insidious, little understood, and often invincible foes.

Contrast this with the ease of surgery now, and we can readily see why it is so much more attractive; why the number of operations and the corps of surgeons in the community are so largely increased.

These are happy days for the surgeon. Although misfortunes happen, they are rare; and the operator expects a good result as the rule, a bad one as the exception.

It is a cause of satisfaction, if not of pride, that our Hospital is fully abreast of others in the improvements, the sanitation, the asepsis of this golden age of surgery. Let us remember with gratitude our predecessors who gave their life's energy to found and build up the City Hospital.

From the opening of the Hospital in June, 1864, to the present year (November, 1896), a generation has passed. During these thirty-two to thirty-three years the surgical staff has lost *eight* surgeons by death.

Dr. Charles H. Stedman, beginning his service at fifty-nine years of age, remained only two years connected with the Hospital. He had had a fairly large experience in surgery in the United States marine hospitals.

His sound advice was tempered by a kindly humor. He was a valued consultant, and fertile in therapeutic expedients. Already debilitated by a failing heart, he died in 1866. Of him it might be justly said that he gave much of the force of his last years to our service.

At about forty-two years of age, and in the prime of years and practice, Dr. Charles E. Buckingham brought to the City Hospital the most original mind of all our colleagues. He always had new ideas: usually practical, sometimes eccentric, frequently brilliant. He was a tireless worker; he never gave up a case; he was full of expedients; his advice was usually wise and judicial. He remained with us four years; then he felt that the stress of private practice and justice to those dependent on him, as well as a reasonable regard for his own health, demanded his retirement.

He was a great physician; he had not the training to make a great surgeon. He excelled in suggestions and diagnosis more than in operative surgery. His insight was wonderfully keen, and his intuitive appreciation of the patients' real condition was remarkable. It was a privilege to visit with him, and close companionship with him was an education. Honesty, justice, conscience, were the moving springs of his life. Abrupt, and often regardless of the *convenances* of polished society, he was rugged, firm, and true.

Dr. D. McB. Thaxter, at the age of thirty-six, entered service as a full surgeon, having previously been a general practitioner. He remained eight years, until he died.

A chronic affection rendered him unable to do his service at the Hospital for nearly two years before his death. He was faithful to the Hospital, but perhaps overburdened by too numerous duties.

Dr. Charles D. Homans at thirty-eight years of age brought to the Surgical Staff of the City Hospital a good surgical training and proclivities, and a remarkable common sense. He remained in service twenty-one years. He had one of the quickest minds to see only the sensible I have ever met. He did a great deal of surgery in the Hospital. He was always on hand, and very punctilious in his duties. We shall long miss his good advice and counsel.

From 1866 to 1884 the Hospital was well served by Dr. William H. Thorndike, who entered the staff at the age of forty-two. With his early training he combined a practice isolated, and often the scene of emergencies and accidents. He became a thoroughly self-reliant surgeon, both from the necessity of his position and from natural force of character. He was, of those who have died, the best surgeon, the most thorough, the boldest and best operator. He did many unusual operations. He was one of the earliest to open a deep appendicular abscess; he tied the iliac; he removed a paving stone from the peritoneal cavity with success; he tied the gluteal in its aneurismal sac. He was cool, well-poised, quiet; a calm worker, and always up to the task before him.

Dr. George Derby ripened late, entering the army when past forty, and thenceforward developing those active professional traits which made him a good military surgeon, and, above all, an authority in hygiene and in sanitation. He remained with us only two years.

Dr. Francis C. Ropes, at thirty years of age, and a young man of great promise, entered our staff, but in one year was cut off by death. His brief service was pleasant and useful to all. Had he lived, he would have developed into an enterprising surgeon.

Dr. William C. B. Fifield received his appointment at forty-one years of age, and served fifteen years. He had taken the degree of the Royal College of Surgeons, and he was trained in the London Hospital. He was an omnivorous reader and student. Possessed of a remarkable memory, his knowledge was too encyclopædic for prompt condensation; for, after all, the surgeon must find within himself those resources which result from well-digested observation. As a consultant, Dr. Fifield could refer you to endless authorities and cases. A ready and witty talker, he enriched his teaching with apt anecdotes, and he was one of the kindest of men to his patients.

The one guiding impulse of all our deceased colleagues was professional loyalty and harmony as a staff. This was truly remarkable, and I fear may be exceptional.

Hos olim meminisse juvabit.

XIV.

STERILITY IN THE MALE.

By John G. Blake, M.D.

The rare mention in current medical literature of this subject is the chief reason for this paper. A short summary of the views of writers may not be out of place, and the report of two cases of a rare form of the affection may have some interest for gynæcologists.

Sterility in the male is that condition in which, if there be any seminal fluid at all, it lacks all fecundating power. The absence of this power may be dependent upon one of two conditions, namely: the semen may be ejaculated in normal amount, but the spermatozoa are either entirely absent or dead when discharged (this constitutes the condition of azoöspermia), or there may be a total absence of all seminal fluid, constituting what is known as aspermia. In both cases the act of copulation may be complete. As a corollary to the above two conditions, we might mention malemission, the condition in which the semen is discharged into the male urethra, but is not ejaculated into the vagina.

First of all we will discuss the condition known as azoöspermia, or the ejaculation of semen in which the spermatozoa are either dead or absent when discharged. This condition may be due (1) to failure of the testicles to produce spermatozoa, or (2) to mechanical obstruction in some part of the passage by which the spermatozoa reach the urethra. The testicles fail to secrete spermatozoa when there is a bilateral retention or a bilateral atrophy, or malignant, syphilitic, or tubercular degeneration of both glands. It is also obvious that no spermatozoa will be secreted when both testicles are absent either congenitally or from castration. Occlusion of any part of the excretory ducts may be either congenital or acquired. The latter is the more common;

and of the acquired forms, bilateral gonorrhœal epididymitis is by far the most common. Among the rarer causes we may mention wounds, syphilitic and tubercular degenerations, and pressure of tumors, whether benign or malignant.

Aspermia is that condition in which either no semen is produced, or it is entirely retained in the seminal vesicles, and no ejaculation takes place. The latter condition occurs only when there is an occlusion of the common ejaculatory ducts, and would not be produced by obstruction of the vasa deferentia. Occlusion of the common ejaculatory ducts is usually caused by posterior urethritis, but it may be congenital, or be caused by traumatism (chiefly that inflicted by surgeons in operating for stone). Concretions are a very rare cause of obstruction of the ducts. The forms of obstruction mentioned above produce, it is true, an apparent condition of aspermia; but, strictly speaking, it is not true aspermia, for semen is produced, although it is retained in the vesicles or in the ducts.

True aspermia is a much rarer condition, and may be due to anæsthesia of the glans penis, whereby there is no reflex excitation of the ejaculatory centre in the cord. Occasionally anorchids, while incapable of procreation, nevertheless have sexual desire and occasional involuntary emissions, and are quite able to copulate.

Malemission is the condition in which — although testicles and accessory sexual glands secrete normal seminal fluid capable of fecundating — the fluid is not properly ejaculated into the vagina, but is retained in the male urethra, and exudes drop by drop after coitus has been completed; or the power of ejaculation may be perfect, but owing to some fault in the urethra, such as hypospadias, epispadias, or fistula, the semen escapes from the urethra before it reaches the vagina. The patient suffering from this condition cannot be said to be sterile, neither is he impotent, yet the result is the same: he is incapable of procreation. In view of the fact that about one woman in eight is barren, and that the proportion of sterile men is about the same, it becomes a matter of considerable importance for the physician to decide in which, the husband or wife, the trouble lies. It is usually the young wife who comes to the physician on account of

barrenness. The husband is not apt to be as sensitive on this point, since it means a great deal more to the woman. The semen, if there is any, should be thoroughly examined for living spermatozoa. This should be done under the microscope soon after it has been passed. If the spermatozoa are found to be alive, of course the man is potent and we must examine the woman more thoroughly. This applies to cases where the semen is ejaculated normally. Of course the semen, while it is perfectly normal, may nevertheless never reach the vagina. Sterility in the male has been confounded with impotence, no distinction having been drawn between the inability to procreate and incapacity for sexual intercourse.

Among gynæcologists no inconsiderable number of the cases they are called upon to treat are for the cure of sterility in the female: and many times only failure attends the efforts, when from all appearances and results of local successful treatment the opposite should follow. In a general way, of course, we are aware that from many causes, congenital and acquired, the failure may be in the male, but the actual demonstration by microscopic examination is not often resorted to. Recently it has come under my observation to have this done, and in two cases the results showed that the fault did not belong to the female; and the curious feature of the cases was that in neither of the two was there the least suspicion that the man was in fault. Both were fine specimens of manhood, with keen sexual appetites, married to perfectly healthy young women. Number one was a man in the prime of life, six feet high, weighing about 180 pounds, living in the open air most of the time, of temperate habits and correct life, with no hereditary tendencies; brothers and sisters married and fruitful; had been married to a woman a few years his junior, but perfectly healthy and of healthy family, for nine years, yet the woman was never pregnant. She consulted me for sterility. I took her into St. Elizabeth's Hospital, and under ether could detect nothing abnormal in the condition of the pelvic organs. The uterus did appear to be a little spongy, with a possible endometritis. It was dilated, curetted, and packed, more with a view of insuring a

pervious canal and healthy endometrium than for any marked evidence of existing disease. When in the course of a couple of weeks she left the hospital I felt very confident that there was no obstruction to conception on her part. She had always been perfectly regular in regard to the menses. I was looking for success as the result of the operation, but it did not come. Month after month passed without interruption of the menses. I finally became convinced that the fault was not on the woman's side. A microscopic examination of the semen made in Dr. Councilman's laboratory twice within a month showed an entire absence of spermatozoa in both specimens, much to the husband's surprise. He assured me that he never had had any private disease, gonorrhœal or syphilitic, never received any injury, and was not aware of any defect in his organization; he had always enjoyed married life, was vigorous sexually, and had no malformation or atrophy of organs. His disappointment was keen.

Number two was an Italian in the prime of life, married for the second time to a young and perfectly healthy woman ten years his junior. They were devoted to each other, and were very much disappointed that no children came. An examination of the wife showed a small os, but normal uterus. Menstrual function regular and not painful. No ovarian disease. The cervix was dilated and packed with gauze for a week, and afterwards an Outerbridge wire dilater inserted. No result. Some months afterwards the cervix was again dilated to insure an open and straight canal, but without success. After this it was deemed wise to investigate the husband's case. Before doing so, the second wife of the husband's brother remarked that it was useless to be treating the wife, as the fault was not with her, but with the husband, and that it was a family peculiarity. She was a second wife, and had never been pregnant. Her husband's first wife, although a healthy young woman, had never been pregnant. My patient's husband's first wife had been a young and healthy Italian woman. She had never been pregnant; and so it ran through the family. Husband claimed to have been free at all times from disease of a specific character, showed no re-

sults of previous disease, and was free from malformation of any kind. Microscopic examination of semen showed an entire absence of spermatozoa, as in case number one.

In discussing this subject with gynæcologists, I find that some of them insist upon investigating the husband's condition and satisfying themselves that he is all right before submitting the wife to treatment, unless there is manifest disease which would prevent conception. I think this a wise precaution in many cases.

XV.

A CASE OF LIGATURE OF THE INNOMINATE ARTERY FOR ANEURISM.

By George W Gay, A.M., M.D.

Ligation of Innominate Artery for Aneurism Involving Innominate, Subclavian, and Common Carotid Arteries; Faulty Asepsis; Hemorrhage on the 32d Day; Ligation of Common Carotid Artery; Death on the 42d Day from Repeated Hemorrhages.

Mrs. M., widow, 39 years of age, born in New Brunswick, had been in the Hospital several times for various affections, anæmia, cardiac stenosis, pelvic cellulitis, and movable right kidney, previous to her last illness. The maternal side of her family was phthisical, the mother having died of that disease; otherwise her family history was negative.

The present illness dates back two years, when she first began to notice the three most prominent and most permanent symptoms; namely, dyspnœa, dysphagia, and painful pulsation at the root of the neck. The difficulty in breathing was accompanied by severe paroxysms of coughing, which often compelled her to sit up in bed for hours at a time. The pulsation or throbbing in the lower part of the neck was attended by a dull aching pain, which extended into the right axilla, and through to the back. The dyspnœa, the pain, and the throbbing were all very much aggravated by all kinds of physical exercise or mental excitement. The difficulty in swallowing had become so marked that solid food could not be taken at all, and she was obliged to swallow liquids slowly, carefully, and in very small quantities at a time to avoid painful choking sensations. She had violent headaches at times, and for several

weeks before coming under our care she had suffered from considerable pain in the upper part of the abdomen, and from a mild diarrhœa.

During the past six months all of this woman's symptoms had grown steadily worse, and she had become an invalid, unable to do anything to support herself. She had lost flesh, color, and strength, and was in a pitiable condition. Having been under the observation of Dr. M. P. Smithwick for a long time, he, recognizing her disease as well as her serious condition, admitted her to the Hospital on my service, Oct. 19, 1896.

The patient was a rather spare woman with dark hair and eyes, a fairly calm temperament and good courage. To the right of the median line of the neck just above the sterno-clavicular articulation was a diffused pulsating tumor about an inch and a half in diameter. The pulsation was plainly seen, as well as felt, and was much more violent than upon the opposite side of the neck. The pulsation in the carotid artery above the tumor and in the radials was normal to the finger. No difference could be detected between the arteries in the wrists, either in strength, fulness, or rhythm. No change could be felt in the coats of the superficial arteries.

The tumor was situated underneath the lower end of the right sterno-mastoid muscle at the usual point of bifurcation of the innominate into the carotid and subclavian arteries. There was no œdema or discoloration of the skin, and no deformity aside from the tumor above mentioned.

A blowing systolic murmur was to be heard all over the cardiac area, loudest at the apex, and extending up the aorta, to and a little above the tumor. No distinct thrill was noticeable. Nothing to be noted about the eyes and ears. The voice was hoarse and she was troubled more or less with mucus in the throat.

Below the ribs to the right of the median line was to be felt a mass the size of an orange, which was somewhat tender and painful at times, and was thought to be a movable kidney. No signs or symptoms of any other affection were found. The lungs were sound, and the urine was normal.

The diagnosis was a fusiform aneurism of the innominate,

subclavian, and carotid arteries. To determine its lower boundaries, and to ascertain if the arch of the aorta was involved, Dr. F. H. Williams carefully examined her chest with the X-ray, and has kindly furnished the following report:

"After careful examination of the patient with the fluoroscope, both Dr. Munro and myself were confident that the aneurism did not extend below the lower border of the clavicle. A radiograph of the neck and greater portion of the thorax, although not satisfactory as a picture, because the patient moved, showed, nevertheless, the outline of the portion of the aneurism above the clavicle. The X-ray examination of this case is of interest, since it indicates that aneurism may be detected when surrounded by tissues, such as muscles, which are much denser than the lung tissue with which in the thorax they are chiefly contrasted, and, further, the statements based upon the X-ray examination were verified at the autopsy."

Rest and all the usual methods of medical treatment having been faithfully tried without giving any permanent relief, the dangers, possibilities, and probabilities of surgical measures were explained to the patient, and the decision of the matter of treatment was largely left to her. After due consideration she decided upon an operation, and it was done in public on Tuesday, Oct. 27, 1896, with the very efficient assistance of Dr. John C. Munro.

Operation.—The patient, having been etherized, was placed in the Bigelow chair, hoping in this way to gain more convenient access to the parts than if she were placed upon the table. A curved incision commencing over the anterior border of the right sterno-mastoid muscle, three inches above the clavicle, was carried downwards and inwards over the left sterno-clavicular articulation to a point three inches below the top of the sternum. This incision was joined by another, three inches in length, over the right clavicle. The triangular flap composed of skin, superficial fascia, and platysma muscle was raised, exposing the double origin of the sterno-mastoid muscle. Both portions of this muscle were carefully divided upon a director close to the bones. The cellular tissue was dissected away, exposing

the sterno-hyoid and sterno-thyroid muscles. The fibres of these two muscles were separated, not cut, and held aside with retractors. A medium-sized vein crossing them transversely was divided between two ligatures. This was the only vessel requiring ligation before reaching the innominate artery.

The right sterno-clavicular articulation, including about an inch of the clavicle, and as much of the upper and outer part of the sternum, was removed readily and easily with bone and gouge forceps. A direct and easy access to the innominate was thus obtained. The sheath of the artery was carefully divided between two small vessels plainly seen, thus avoiding any oozing at the bottom of the deep wound, which is always annoying besides consuming time. The innominate artery was easily separated from its sheath with the index finger, which passed down to the arch of the aorta below, between the innominate vessels and the trachea and œsophagus behind, and between these vessels and the pleura to the outer side. The innominate artery was about two inches in length and at its upper part was about an inch in diameter, *i.e.*, nearly or quite double its usual size. It gradually increased in diameter from the arch of the aorta, its origin, to its termination. Nothing else abnormal was found in the exploration, and three ligatures of braided silk were applied in the following manner: The first was placed three-quarters of an inch above the aorta, and slowly tightened. The second was applied half an inch higher up. The third was merely to reinforce the second, and was applied at the same place. The ligatures were all passed from within outward, although there was sufficient space to allow of their being carried in the opposite direction, if found to be more convenient. They were readily placed in position with a large aneurism needle, tied in three square knots, and cut short.

The wound was closed with silk sutures, a few strands of silk at the angle serving as a drain for the first day or two, and a dry aseptic dressing applied. The right hand and arm were wrapped in cotton wadding, and the patient was removed to her bed. She was in good condition. Pulse 84 at left wrist; color good; respiration natural. The

operation lasted about an hour and a half, but it was practically bloodless. Only one vessel was divided, and that was done because it was in the way. The innominate veins, the internal jugular vein, and the pneumogastric nerve were not seen during the operation. There was no foaming of the cellular tissue, which occasionally gives so much trouble in deep operations about the neck. There were no mishaps of any sort apparent during the operation. Everything was done deliberately and with care, no hurry nor excitement.

The only immediate effects noticed from securing the ligatures were cessation of pulsation in the tumor and the arteries above it on the right side of the neck, and in the corresponding radial artery. She came out of the ether well, and had no vomiting. Complained only of a little soreness at the site of the wound.

About seven (7) hours after the operation a slight pulsation was detected in the right radial artery. It was synchronous with the left radial, but never increased any in strength or volume during the patient's life.

The day after the operation the patient was very comfortable. Pulse 75, temperature 99. Had no difficulty in swallowing except from the mucus, which gave her a little trouble. No cough nor dyspnœa; no dizziness nor headache; no numbness of right hand and arm; no change in right pupil. In short, to all outward appearances she was doing perfectly well. Took $\frac{1}{12}$ grain morphine under the skin last night.

4th day. Patient comfortable. Pulse 80, temperature 99.5°. Wound dressed and drainage removed. It was dry, clean, and presented no signs of mischief going on underneath. Took food very well, and slept fairly well.

6th day. Pulse 92, temperature 100.4°. This being the crucial day for bacteria, the dressing was removed and the wound found to be infected. The flap was red and swollen. The discoloration was not confined to the suture punctures, but was more general. A little purulent matter was escaping from the angle of the wound whence the silk drainage was removed forty-eight hours before. Thorough irrigation with corrosive solution and peroxide of hydrogen

was ordered every four hours, hoping thereby to check the suppuration, if the infection should chance to be superficial.

The patient was very much more comfortable than before the operation. All of her old troublesome symptoms had disappeared. She breathed easily, swallowed readily, and had no cough nor painful throbbing at the site of the aneurism. The operation had thus far produced very little disturbance of any kind.

10th day. Wound entirely healed except at angle of the flap, where there is a small sinus, which extends upward under the skin an inch and a half; redness and œdema have disappeared: discharge less. Frequent dressings continued. Codeinæ in half-grain doses occasionally at night, for restlessness. Takes food well. Stimulants not required. No medicine except as stated above.

14th day. Discharge from sinus very slight. Pulse and temperature normal. Is very comfortable in every way. Reads the papers as usual.

19th day. Disturbed by an alveolar abscess due to decayed teeth. Relieved by incision and poultice. Marked pulsation is to be felt over the right common carotid artery, near its origin, accompanied by a distinct systolic murmur.

23d day. Sinus appears to be closing; discharge very slight. Patient natural in appearance, and comfortable; no complaint.

27th day. Had some pain in cardiac region last night. No disturbance in pulse or temperature. In good condition, to all appearances. Discharge from sinus very slight.

32d day. Hemorrhage. Syringed out the sinus this morning, and while debating as to the necessity of enlarging the opening, blood began to well up from the aperture. It came slowly, not in a gush, or in jets. Easily controlled by making pressure for a few moments with the finger over the upper end of sinus.

Patient immediately removed to the operating-room, and etherized. On slitting up the sinus an inch, a cavity the size of a small almond was exposed, at the bottom of which was a sinus an eighth of an inch in diameter, extending inwards in the direction of the deep ligatures.

In view of the facts that the secondary hemorrhage in

these cases frequently comes from the distal end of the vessel,[1] and that for weeks there had been distinct pulsation in the right common carotid artery, thus justifying the possibility of that vessel's being the source of the hemorrhage, the artery was exposed, and tied with a silk ligature about an inch above its origin. Wound closed completely, and sinus packed with iodoform gauze. Patient bore the operation well, and was none the worse for it, to all appearances.

34th day. Very comfortable day yesterday, but pulse and temperature rose steadily all day, the former reaching 108° and the latter 104.5°. At midnight there was a pretty smart hemorrhage, which had ceased before the house-officer reached the ward. No syncope, but a good deal of fright and mental disturbance, as might be expected. She is more feeble, and looks paler than would be supposed from the amount of blood lost. May be partly due to sepsis, although externally the wound looks well enough. Pulse 80° to 108°. Temperature, 97.8° to 99.3°. She is evidently wearing out from the effects of the hemorrhages, sepsis, and mental strain. For restlessness or pain she receives an occasional dose of one-half grain of codeinæ sulph.

35th day. Another hemorrhage last night, more profuse than the other two, and the patient was more prostrated by it.

36th day. Very comfortable, no hemorrhage; stitches removed from carotid wound, which had healed by first intention. Pulse 100; temperature normal. Pale and weak. Takes food fairly well; no delirium.

38th day. Some difficulty and pain in moving right arm; it feels numb and cold to herself. Suppuration from open wound very slight. No hemorrhage.

39th day. Profuse hemorrhage this morning; quickly and easily controlled by pressure. Steadily growing weaker.

41st day. No more hemorrhage until this morning, which like all the others was easily controlled by pressure. Pulse weak and soft, and with the temperature continued to rise all day, the former reaching 120 and the latter nearly to 105°. Patient weaker, and has been a little delirious at times for past few days.

[1] Dr. H. L. Burrell., Trans. Am. Surg. Ass., Vol. XIII., p. 291.

Just before midnight a severe hemorrhage occurred, from which she did not rally, although the bleeding stopped of itself by reason of syncope of the patient. She was nearly pulseless; sighing respiration: unconscious. Quick and powerful stimulation failed to sustain her, and she died in about an hour and a half, or early in the forty-second day of the operation, and the eleventh day of the hemorrhage.

AUTOPSY DEC. 7, 1896.

By Dr. Leary.

The following is his report:

Clinical diagnosis: Aneurism.

Woman about 40 years old. Well developed, well nourished. Operation wound extending along the anterior border of the sterno-cleido-mastoid muscle 5 cm. below angle of jaw, just below the right sterno-clavicular articulation. The wound in its upper portion healed, the portion to the right of the sterno-clavicular articulation closed by stitches. A thin, bloody, watery fluid exuded on pressure. This wound was dissected down upon. The tissues surrounding it were infiltrated with blood, and it extended down to the innominate artery, around which was formed a cavity about the size of a walnut, filled with clotted blood, fibrin, and serous fluid. The dissection was continued up the neck as far as the bifurcation of the carotids, and along the chest to 3 cm. beyond the origin of the subclavian artery, and from hence down to the heart; the heart and above vessels being removed in mass. At a point about 2 cm. above the arch of the aorta, and surrounding the remains of the innominate artery, was a thickened mass, in the centre of which was the above-mentioned cavity, which corresponded to the preëxisting aneurismal sac. This cavity contained the remains of the innominate artery, around which were found, at a point 2 cm. above the arch, two silk ligatures together. One cm. above this arch was a single ligature, and just below this point the continuity of the artery was lost. The divided ends were shreddy and covered with fibrin. A probe could be passed directly through the innominate artery into the arch of the aorta. About 4 cm. above the bifurcation of the innominate, the common carotid artery was tied. The

ends of the ligature could be seen projecting, but the remainder of the ligature was concealed by newly formed tissue. The artery above and below this point was closed by a thrombus. The subclavian artery, with its branches, thyroid axis, vertebral, superior intercostal and submammary, were much dilated. All other arteries and veins met with in dissection were also much dilated. Some of these vessels showed small, slightly elevated, yellowish patches, particularly the subclavian artery.

Abdomen. — No excess of fluid in peritoneal cavity. Peritoneal surface smooth. Intestines and mesentery very anæmic; the appendix, about 7 cm. long, lying over brim of pelvis.

Both pleuræ adherent to diaphragm. Free in other parts. The lungs showed some emphysema; universally pale. Bloodless except around the cut vessels, where there was some staining. The right lung, lower lobe, showed an old healed area with adhesion to the chest wall.

The bronchial glands much pigmented, and some of them calcareous.

The pericardium normal. Heart, wt. 300 gms. In the right ventricle in the columnæ carnæ was a hard calcareous mass beneath the endocardium. On one of the mitral cusps well up towards its attachment was an elevated, firm, yellowish area about the size of a split pea.

Liver, wt. 1,080 gms. Bloodless; markings normal.

Spleen, wt. 140 gms. Pulp slightly increased. Follicles not distinct. Trabeculæ and blood-vessels apparently normal.

Kidneys, wt. 240 gms. Relation of cortex and pyramids normal. In the left kidney was noticed an area about the size of a pea containing yellowish softened material. In the right kidney were several small pinhead areas with the same yellowish material, evidently purulent. In one place along the edge of a pyramid there was a row of 6 or 7 of these small areas.

Smears from the contents of these areas showed many pus cells, and cocci occurring singly and in groups.

Stomach, intestines, pancreas, and adrenal glands normal.

Uterus normal. Tubes bound down on both sides by adhesions. On the right side, connected with the parovarian, was a cyst about the size of an English walnut, with thin walls, and containing a clear serous fluid.

Heart not opened.

The aorta showed several slightly elevated, yellowish patches, not calcareous, more marked just above the bifurcation into the iliacs. The first left intercostal artery is obliterated just above its origin, and beyond this point is much dilated, as is also a small branch running off from it.

Anatomical Diagnosis.

Operation wound with remains of aneurismal cavity. Rupture of the innominate artery, one end of which had three ligatures. Myocarditis. Arterio-sclerosis with obliteration of lumen of the first left intercostal artery. Multiple abscesses of kidney. Parovarian cyst. Acute hyperplastic splenitis.

Cultures.

Operation wound — two colonies of staphylococcus pyogenes aureus.

Heart — staphylococcus aureus.

Liver — three colonies of staphylococcus pyogenes aureus.

Spleen — eight colonies of staphylococcus aureus.

Kidney — fifty-three colonies of staphylococcus pyogenes aureus, colon bacillus.

MICROSCOPIC EXAMINATION.

By Dr. Councilman.

Microscopic examination of the tissues was made at various places, including the innominate. A section through a portion of the innominate included between the two ligatures shows the media of the artery folded upon itself, and cut through at one point. The remains of the ligatures are found in the tissue. The ligature is infiltrated with pus-cells and with a few granulation tissue-cells. The artery appears to be necrotic; it contains no cells, and only the remains of the elastic and muscular tissue can be made

out in it. The wall of the artery contains very few pus-cells, an invasion having taken place at only a few points. In this section of the tissue there are numerous masses of micrococci. These are found principally in the wall of the artery, at the point ligatured, and in the remains of the ligature. The section embraces the adventitia and the adjacent tissues. These are all infiltrated with pus-cells, bacteria, and hemorrhage.

Section of the innominate 1 cm. above its origin from the aorta shows at this point small masses of thrombi adherent to the intima. The intima is thickened and degenerated. The media is in high degree sclerotic. The adventitia of the artery here forms a part of the abscess cavity which represented the original aneurismal sac. It is infiltrated with hemorrhage and pus-cells, and shows here and there in the tissue single silk fibres, the remains of the ligature at this point. In the wall of the aneurism itself only here and there portions of the arterial wall could be distinguished. The whole tissue was infiltrated with pus-cells and bacteria.

Section of the carotid artery passing through its origin from the innominate shows it to be occluded by a thrombus which extended into the innominate. The portion of the innominate artery included in this section was in high degree degenerated.

The results of the microscopic examination show a high degree of arterio-sclerosis of the innominate artery at the point of the aneurism. The artery at the point of origin of the carotid was also extensively degenerated. The original aneurismal sac was converted into the wall of an abscess, and only the remains of the tissue of the artery could be distinguished in it. At the point of ligature of the innominate the artery was folded on itself, fractured at one place, and the tissue here invaded by bacteria and leucocytes. From the number of bacteria found at this point it would appear that this probably represented the original point of infection of the artery.

Remarks. — This operation failed because the asepsis was imperfect. The asepsis was imperfect because of the uneven and faulty action of the sterilizer. It was a comparatively

new machine, and its work was supposed to be reliable. At that time the failures had not been sufficiently numerous to excite suspicion. Great care was taken in making all the preparations for the operation, as well as in doing the operation itself, and we were at a loss for an explanation of the unfortunate and unexpected result, until Dr. Lovett took cultures from the braided silk ligatures, such as were used in this case, and found staphylococci. He also found that while the gauge upon the outside of the sterilizer showed a germicidal temperature, a self-registering thermometer inside showed that the temperature was not always raised sufficiently to render the silk sterile. At the autopsy Dr. Councilman found the greatest number of bacteria in and about the ligatures. These facts would seem to afford a reasonable explanation of the infection of this wound, and hence of the probable failure of the operation.

That this patient should live six weeks, and be ten or eleven days in bleeding to death from one of the largest arteries in the body that is ever tied, and the lesion be within three or four inches of the "power station," — the heart, — is surprising, to say the least. One would naturally suppose that the first hemorrhage would be sudden, profuse, and fatal, while the fact was that a moderate hemorrhage seemed to relieve pressure in the arterial system sufficiently to stop the flow of blood without treatment of any kind. Ligating the common carotid artery did no good nor harm. The patient was not disturbed at all by the operation, and the wound was healed in three days. The blood came from the proximal and not the distal portion of the vessel.

The comparatively slight disturbance to the patient produced by this operation was remarkable. Aside from the stiffness and soreness in the neck upon motion or in clearing her throat of mucus, there was very little suffering. She took one-twelfth of a grain of morphia the first night after the operation, and no more sedative of any sort for several days. I can see no reason why ligation of the innominate artery should not be as successful as tying the common carotid. It is largely a matter of asepsis, and herein lies the principal advantage of modern surgery in the ligation of arteries. Formerly, as we all know, the dangerous period

was that of the separation and expulsion of the ligature. The moment that process is done away with, as in closed aseptic wounds, then all danger from secondary hemorrhage ceases.

As showing the immunity from cerebral symptoms in these operations, allusion may be permitted to the justly celebrated case operated upon by Dr. J. Mason Warren,[1] in which he tied both carotid arteries for an aneurism by anastomosis of the face and neck. The operations were only a month apart, and yet the only unpleasant symptoms following were drowsiness, and a slight faintness on trying to raise his head from the pillow after the second operation. These symptoms were transient. He recovered from each operation in ten days, and was alive and well three years later. These operations were done in 1845, before the days of anæsthetics and antiseptics, and hence are of greater interest and value.

The writer tied both common carotid arteries a few years ago for aneurisms in a young man. The operations were about one year apart. No disturbance of any sort followed either operation. Union took place by first intention, and the convalescence was short and satisfactory. He was alive and able to work for about three years after the last operation.[2]

Recent experience shows the importance of applying two ligatures to this vessel to insure complete and permanent closure of its lumen. They should be placed about half an inch apart, if space will allow. The distal ligature is depended upon to permanently close the vessel, and the proximal one acts as a "breakwater" to protect the first from the powerful concussion of the arterial current. In Dr. Burrell's case the proximal ligature, knot and all, cut its way through the arterial coats, and was found inside the vessel, the lumen of which had been restored. Had there been but one ligature, the results could be easily imagined. The distal ligature had accomplished its object perfectly.

In aseptic wounds the lesions made by the ligatures are promptly protected by the new reparative material, thus

[1] Surgical Observations with Cases, p. 446.

[2] Not long afterwards he was found dead in his bed in the morning. Cause not known to the writer.

averting any danger from hemorrhages. In Thomson's[1] case of ligation of the innominate artery with a single ligature of ox-aorta, death from hemorrhage occurred on the forty-second day. No traces of the ligature were found at the autopsy. The vessel was not completely closed, the clot extending through a small chink in the ligatured portion, and being continuous with that in the subclavian and carotid arteries. As all of these thrombi were solid, and could not be dislodged with a stream of water from a syringe, it was concluded that the hemorrhage came from the vertebral artery. It is fair to suppose that an additional ligature might have completely occluded this vessel, but owing to the local sepsis the result would doubtless have been the same. And, furthermore, it should be said that the aneurism (subclavian) was well advanced toward consolidation. The constriction had probably been sufficient to stop the current in the sac, and that is the object of all operations.

It does not seem wise to divide the innominate artery between the ligatures to relieve axis tension, as has been done with apparently good results in tying the carotid and other large vessels. The violence of the systolic impact, the strain upon the proximal ligature, and the tendency of that thread to cut through the arterial coats, the unreliable character of the proximal thrombus, the lack of the firm lateral support, which is present in the neck, thigh, and around other large arteries, the fact that the innominate artery is surrounded by loose cellular tissue, suspended, as it were, in soft non-resisting structures, would all seem to militate against the practice of severing this artery for fear of secondary hemorrhage. The writer has divided the carotid artery twice between the ligatures, and the subclavian and brachial once each. The retraction of the ends of the vessels within the sheath was marked and satisfactory in all but the brachial artery, the divided ends of which retracted very slightly, if at all. Union by first intention followed in all these cases, and hence the results were satisfactory.

As to the method of doing this operation the writer fails

[1] International Encyclopædia of Surgery, Vol. III., p. 538.

to see wherein any very great improvement can be made over that so clearly described by Dr. Burrell in 1895.[1] The only variation made in the present case was in removing the sterno-clavicular articulation with bone and gouge forceps instead of a trephine. The operation was practically bloodless, only one vessel, the anterior jugular vein, being divided between ligatures to get it out of the way. No other large vessel or nerve was seen during the operation, except the innominate artery.

The cellular tissue was carefully divided between two forceps by gentle strokes of the knife, instead of being torn or picked out of the way with a director.

The collateral circulation in these cases forms an interesting anatomical study for any one disposed to work it out. In a general way it may be said to become established through the left carotid and vertebral arteries, the circle of Willis, the corresponding arteries of the right side, also through the thyroid arteries, the intercostals, especially the superior, the mammary, the profunda and princeps cervicis, and doubtless through many other smaller vessels of the arterial system. It is to be remembered that in ligation or other obstruction of any large arterial trunk, myriads of arteries, previously too small to be dignified with a name, take on a sudden dilatation and growth, and become the avenues of a large quantity of blood. The nearer the heart the obstruction is located, the more pronounced is this change in the vessels. It is in this manner that the nutrition of the brain is maintained at a point which enables it to perform its functions under these extraordinary circumstances. Arterial anastomosis is so free in the upper part of the trunk that almost any vessel may be ligated without fear of resulting gangrene. Perfect asepsis is the key to the situation. With that, success is probable; without it, failure may be expected in a majority of instances.

[1] Op. Cit.

XVI.

SOME NEW ASEPTIC APPARATUS.

By William P. Bolles, M.D.

There are two sets of apparatus described in this paper, one a sterilizer intended for private practice, and designed to secure such asepsis as water and steam at 100° centigrade will effect, and to combine the greatest possible convenience, compactness, and portability in its construction.

The other is a pouring or irrigating flask for sterile solutions, designed for use in hospitals, where absolute theoretical purity is required, and where an apparatus that shall be practically automatic is desirable.

To take them in order, the first is a portable steam and hot-water sterilizer for instruments, dressings, and linen, in which all the necessities for ordinary operations can be arranged and packed at home or in the office, carried easily so packed to the patient's house, and sterilized on the kitchen stove while the surgeon is preparing in other ways and etherizing the patient. Incidentally, it also furnishes all the sterile pans or dishes necessary for the operation, and obviates the necessity of borrowing from the patient's pantry or carrying a set of trays.

If filled, on entering the house, with a suitable quantity of boiling water and baking soda, the water will boil again in from three to five minutes, and at the end of the half hour that generally elapses before the patient is ready, its contents are as sterile as boiling water and steam can make them, the linen thoroughly steamed and dry, the instruments, sutures, etc., boiled in alkaline water and wet.

It consists, in general, of an outside kettle, with cover, within which is an inverted box or hood, just enough smaller than the other in all directions to leave a space of,

say, one centimetre on all sides and on the top for steam and water. Within this hood lie the trays for instruments and dressings, piled one on the other. Thus there are an outer and inner chamber; the inner surrounded by the outer, excepting on the bottom, where both are bounded by the boiling water. By this means the inner chamber is entirely protected from cooling and condensation.

The process of boiling rarefies and expels the air within the inner chamber, and forces it out beneath the hood. As steam is formed it takes its place, and the excess is also forced out in the same way underneath the edge of the hood. The water inside is, of course, pressed down to the level of its escape, and rises in the outer chamber to near the top of the

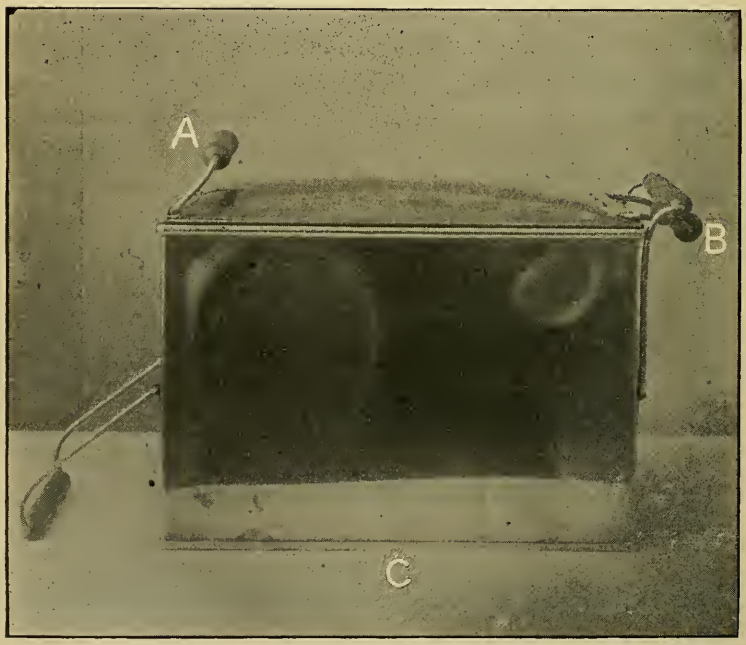

Fig. 1.

sterilizer. Thus we have a thin layer of water boiling in the inner chamber and crowding it with steam, the excess of steam carried out through the column of water at its sides, condensing until that water has attained a boiling point, and then a continual flow of fresh, live steam, permeating the

dressings, and escaping through the outer chamber, until the whole sterilizer is one mass of steam and water. The condensation that takes place on the outer surface drops back into the water, or if it falls on the top of the hood is at a boiling point and causes no condensation within.

To describe the sterilizer more in detail, using a particular pattern (Fig. 1): The kettle and cover have separate

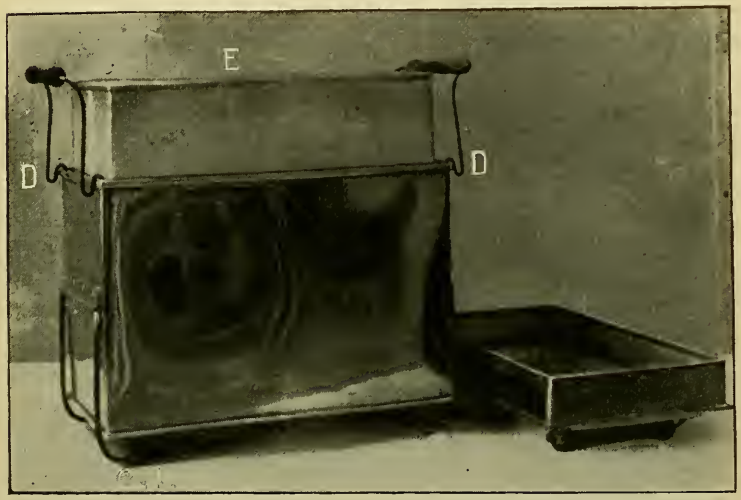

FIG. 2.

handles, as seen at A and B, interlocking in such a way as to form a convenient united handle for carrying, and at the same time to fasten the cover securely down; or, when open, the handles of the cover can be turned back in such a way that when the cover is inverted and laid on the table, they form steadying feet to prevent its rocking and keep it from the table (Fig. 2). The kettle handles, too, can be carried downwards under the bottom of the kettle, as at Fig. 2, C.1, and so form feet which shall raise the kettle and its boiling contents, when set upon the table, so far from the surface as not to scald or damage the table top. The cover is fitted with a deep inside lip, and when taken off and inverted upon the table makes a convenient sterile dish, the very edges of which are

also clean. This exposes to view the inner inverted box, or hood, with two handles connecting with loose peculiarly bent wire loops reaching around the bottom of the whole contents of the outer kettle in such a manner that everything can be lifted bodily out of it and placed in a convenient place. The handles of these loops are of wood, are sterile, can be handled by the surgeon's sterile hands, and no others need touch the apparatus after the cover is off in the course of arranging the trays. In the middle of these handles, as will be seen, is a peculiar bend or hook, by means of which the contents of the kettle can be rested half-lifted out to drip

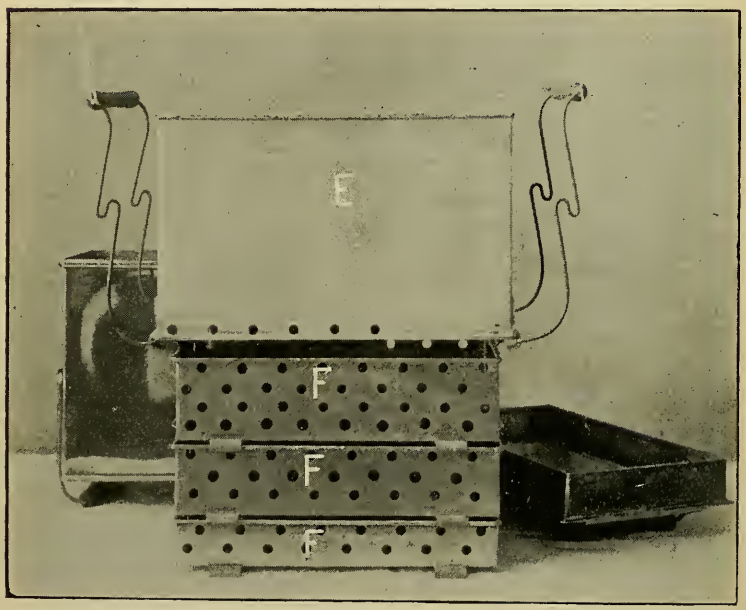

Fig. 3.

and cool as much as necessary (Fig. 2). After this, by means of the same handles, the contents are taken out and laid upon the table, and we have the outer kettle containing a quart or three pints of boiling water, which may be used for rinsing instruments in the course of the operation. The wire loops or handles marked D also serve several other purposes. They have already lifted the hood and the three trays *en masse* out of the kettle, and previously, by means of the

hooks in the middle, have held it half out to drain. Now their further usefulness is shown: The steam hood E has at its four corners four crooked legs, so bent that the wire loops can be slipped into them to the very extreme of the length of the hood by simply carrying the handles apart, and thus disengage the trays within, which they have so far been holding, so that the hood may be lifted completely off (Fig. 3), and at the same time, by a little trick of handling,

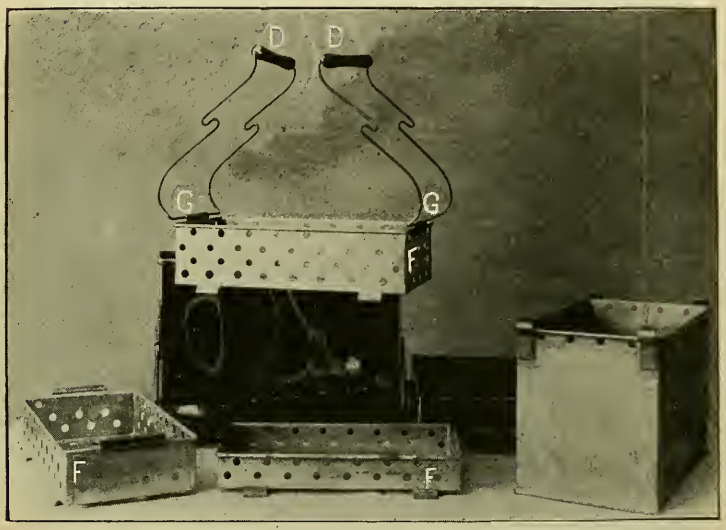

Fig. 4.

inverted and placed in a convenient portion of the table as the third sterile receptacle. This exposes the three trays FFF, resting one upon another, and separated from each other by their feet, which also serve as guides to keep them in position. They are perforated on the sides and bottom, so as to admit of the free circulation of the steam, and they have at the end handles of peculiar construction, so fitted as to prevent end motion, and with the feet, to prevent side motion, they keep them in a straight and even pile, securely locked. The handles also turn out in such a way, as shown at G, Fig. 4, that the loops will lock in and hold them, and enable the surgeon to lift them off from each other and place them in position for the operation. The bottom

tray contains the instruments folded in a towel, which has only to be unfolded to show them laid out in order for the operation. A perforated plate H, Fig. 5, may be laid on the towel enclosing the instruments to prevent water being carried into the tray above by the folds of the towel. The other two trays are above the water line, and contain the dressings, which come out steaming hot, but which, as soon as they are cooled or shaken out, are absolutely dry. A thermometer placed in a central part of the uppermost tray will mark 100 to 100.5 degrees centigrade, showing that the extreme temperature of boiling water has been attained in the thirty minutes that the

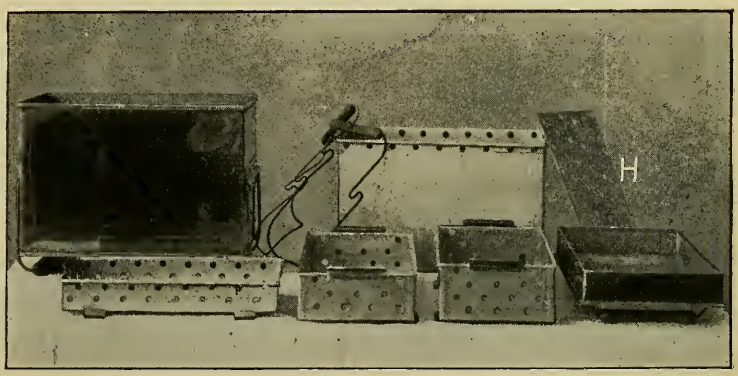

Fig. 5.

apparatus has been on the stove. This temperature, as those who are familiar with the results of bacteriological tests know, does not give absolute certainty of freedom from spores, but as a matter of practical experience it does kill most pathogenic organisms, and those whose persistent vitality enables them to withstand it are comparatively rare, and as a rule easily avoided by a surgeon in private practice, whose instruments and dressings are kept and stored clean and in good condition. On the other hand, it does do what no other sterilizer of its kind achieves so easily. It does reach in all its parts the maximum temperature of boiling water rapidly; it is wholly free from the annoying moisture of dressings, which is caused by the condensation of water on the roofs and sides of sterilizers that are not made with

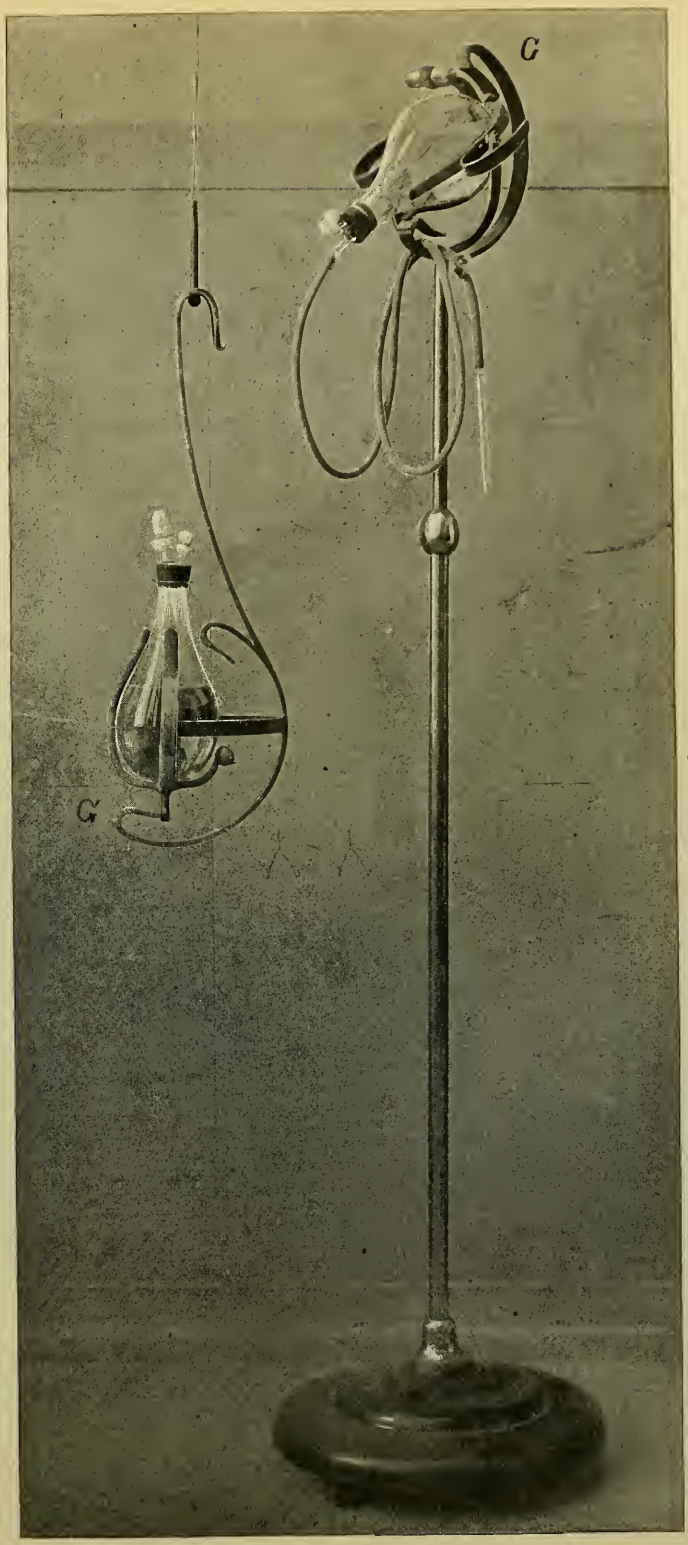

Fig. 6.

a double chamber. It furnishes to a greater extent than any other all the vessels needed in an operation. It is simple and exact in its construction: it is theoretically correct, durable, entirely practicable, and it is impossible that any essential part of it shall be forgotten and left at home. It can be kept packed, excepting for special instruments, and taken at a moment's notice. Ten or twenty grains of bicarbonate of soda should be kept in the kettle, dry.

A simpler form and large size of this apparatus, consisting of a round deep kettle with hood to fit, and suitable wire basket for linen, would answer the needs of small hospitals whose surgeons did not consider steam under pressure essential. In large-sized hoods the circulation of steam could be insured by small pipes on the inside, extending from near the top to openings near the bottom, so that the steam to escape from the hood should rise first to the extreme top. By such a structure dressings could be prepared more uniformly steamed and more dry than by anything now obtainable among the non-pressure steamers.

The next piece of apparatus, as I said in the beginning, is designed especially for hospital use; namely, the production and preservation of absolutely sterile water or solution in a bottle or flask, so fitted that it can be kept indefinitely without contamination, and can be poured freely from it in any quantity, and that all the ingoing air which takes the place of the outflowing liquid shall be strained through a layer of sterile cotton, thus insuring no possibility (direct fraud excluded) of contamination between the autoclave where it is heated and the wound into which it is poured. It is made on the general principle of the chemist's wash-bottle, with currents inverted. That is, the wash-bottle is fitted with a perforated cork containing two tubes, a long one reaching to the bottom of the bottle, and a short one reaching just through the stopper. It is used for forcing out small quantities of distilled water and other liquids, and is operated by blowing air into the short tube, thus forcing the liquid out through the long one, with the flask in an upright position. These flushing or pouring flasks, Fig. 8, etc., are also fitted with two tubes, a long and a short one, but are to be inverted when used, when the water flows out in a

continuous stream through the short tube, while the air flows in equally through the long tube and through the disk of sterile cotton which has been tied on to the end of it. The principle is thus absolutely simple: the column of water passing out through the nozzle of the short tube draws in an equal column of air through the long tube. But the details have been worked out by a series of experiments to a considerable degree of refinement. The size and shape of the flask have been such as prove most convenient in handling and in furnishing a sufficient quantity of solution. The neck is large enough to make an easy grasp for the hand.

Fig. 7.

The flask is rounded in such a way that its centre of gravity is not much disturbed by its inverted position when placed

in one of the holding cages to be described further on. The glass, of course, must be moderately thin, and sufficiently well annealed to stand the high variation of temperature. The neck is flared just enough to receive the ordinary taper of the cork or rubber stopper, and allow it to fit its whole length. The two tubes must be unequal in size, at least in the inner diameter; the air-tube much smaller than the tube for pouring, otherwise drops of water will trickle down and leak untidily out from the air-tube. The air-tube should be made of what is called barometer tubing, and have an inside diameter of not more than two or three millimetres; while the inside diameter of the pouring tube should be about three times as much.

In finishing the lower end of the air-tube the glass-blower should be very careful not to contract it, while the upper or outer end should be expanded to a sort of funnel, in order to give a considerable surface for the air to enter through the sterile gauze. At its lower end the air-tube should be gently curved toward that side of the flask which is uppermost when the flask is inverted for pouring. By this means it most readily gets above the surface of the water, and the inflowing air is less interrupted. The pouring tube and nozzle is made with a little shoulder at the top of the cork, to prevent its being pushed too far within, and also another shoulder near the end, to assist in retaining the cotton cap when it is put on. This end is tapered to fit a rubber tube, or to be used itself as an irrigating nozzle.

For use these bottles are filled with water or salt solution to be sterilized, the corks, with their tubes in, properly inserted, and a little layer of sterile cotton or gauze is folded over the end of each tube and fastened there with an elastic band, as shown in Figs. 6–10. This is then put into the autoclave and sterilized by heating to a proper degree of temperature and for a suitable length of time. It is cooled slowly, the pressure reduced slowly, to prevent too much ebulition, and then is ready for immediate use, or for laying aside until needed. The cotton plugs, of course, are not to be touched until the instant of use. When the solution is wanted, the plug covering the short pouring-tube is removed, the flask inverted, and the solution begins to flow

out. This carries the air in through the other tube, and the circulation thus begun is kept steadily up until the flask is emptied or is returned to a vertical position. The gauze or cotton on the air-tube is not to be removed, but the air allowed to strain through it.

These flasks can be made with various nozzles, or connected with long abdominal irrigating tubes, or with the usual rubber tubing, as in ordinary irrigation. They can also be sterilized with a hood or "cosey," as the housewives used to call it when placed over their tea-kettle, fastened over them, in which case, the outside of the flask being sterile, it can be handled by the surgeon himself in adjusting the irrigation exactly as he wishes to.

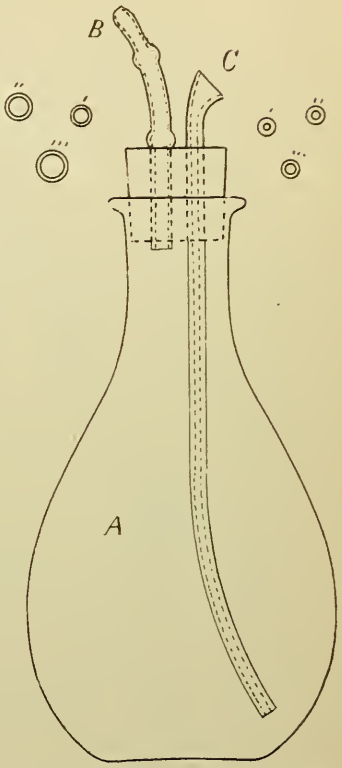

FIG. 8. — Irrigation flask complete, less than one-third linear size. A: Flask holding about one and a half litres, fitted with twice-bored stopper (of rubber or cork). B: Pouring-tube with two shoulders and suitable nozzle. C: Air-tube of small internal diameter. "',"" "","" "",": Sections showing the proper relative sizes of the pouring and air tubes inside.

In a majority of cases, pouring-flasks of this kind will be used directly on the patient; either the water poured in a stream from the flask, or by means of the long nozzle, mentioned above, inserted into the wound, but with the usual rubber irrigating tube they can be used exactly as the rubber bags, or irrigators, have heretofore been.

Occasionally, in operations and in ward dressings, it will be desirable to use the irrigation a little at a time and from a considerable height, and here, as it might be inconvenient for the orderly or nurse to always hold the bottle at a sufficient height and steadiness, and for

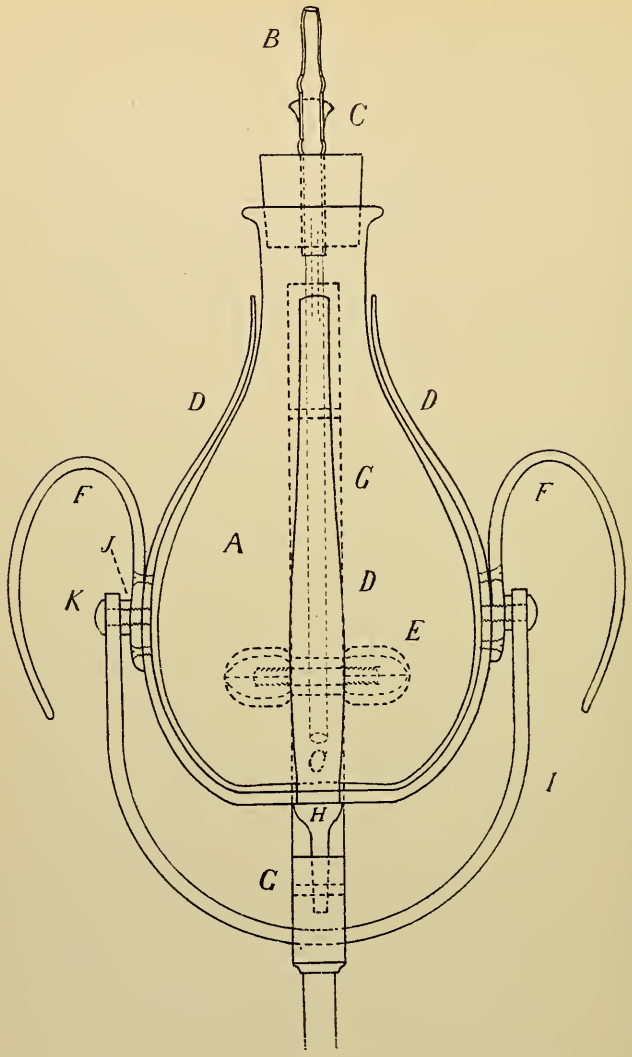

FIG. 9. — Front elevation of the holder. A: Flask holding about one and a half litres, fitted with twice-bored stopper (of rubber or cork). B: Pouring-tube with two shoulders and suitable nozzle. C: Air-tube of small internal diameter. D: The arms of the cage or basket holding the flask. E: Counterpoise. F: Handles. G: Semi-circular stop limiting the rotation of the cage and flask. H: Striker on the cage bringing up against the stop. The neck of the flask and the front arm of the cage are also limited in rotation by the stop dividing the shock and preventing breakage. I: Crutch on which the cage and flask rotate. K: Bolt forming the axis of rotation screwing into handles and cage, and tightened by clamping nut and washer.

a sufficient length of time, some sort of a stand is desirable. There are presented here several patterns. The require-

ments of such a stand in its highest degree of perfection are, that it shall take the flask easily; shall hold it securely, without any danger of losing or breaking it; shall hold it at any desired height; shall hold it upright when not in immediate use; be capable of inverting it with the greatest ease when it is wanted, and returning it again to an upright position. The mechanism of such a stand should be simple, be durable, and be so constructed as to make it impossible to get it out of order or use it wrongly.

One such stand is shown in Fig. 6. It consists of a wooden foot on casters, a brass extension standard of two tubes held in position by a taper nut, and a frame or cage above for holding the flask. This cage will be best understood by consulting Fig. 7, and consists of a four-armed frame, open at one side in such a manner that the flask can be inserted at nearly right angles to the axis of the cage, and when brought into its position is locked so that it cannot fall or shake out. This cage consists of three arms passing vertically around the flask and fitting its contour, and a fourth arm passing about one-quarter of the way up and then turning outwards to form the opening through which the flask can be inserted. The cage is suspended (Figs. 6–9–10) on its axis somewhere near the centre of its gravity, and at the same place are inserted two handles, one on each side, by which it is easily inverted. The short arm is weighted so as to hold the cage securely in an upright position, and the whole thing is balanced so that when it is tipped in such a way as to point the flask downwards to an angle of about forty-five degrees it shall balance in that position and not tend to return. In short, the flask will be held securely either upright or inverted, according to the will of the operator. This whole cage is balanced on two crutches rising from a pin in the top of the standard, and it is checked in its motion by a semi-circle, to which the crutches are welded, and whose infolded ends strike the pin projecting downward from the base of the cage, while the loop formed by their inversion offers a rest for the neck of the flask. Thus in each position there are two stops, one at the neck of the bottle and the other at the bottom of the cage, both of which act at the same time, and thereby prevent any undue

wrench or strain upon the cage or flask. These arms, and all points of contact, are so made that they can be easily

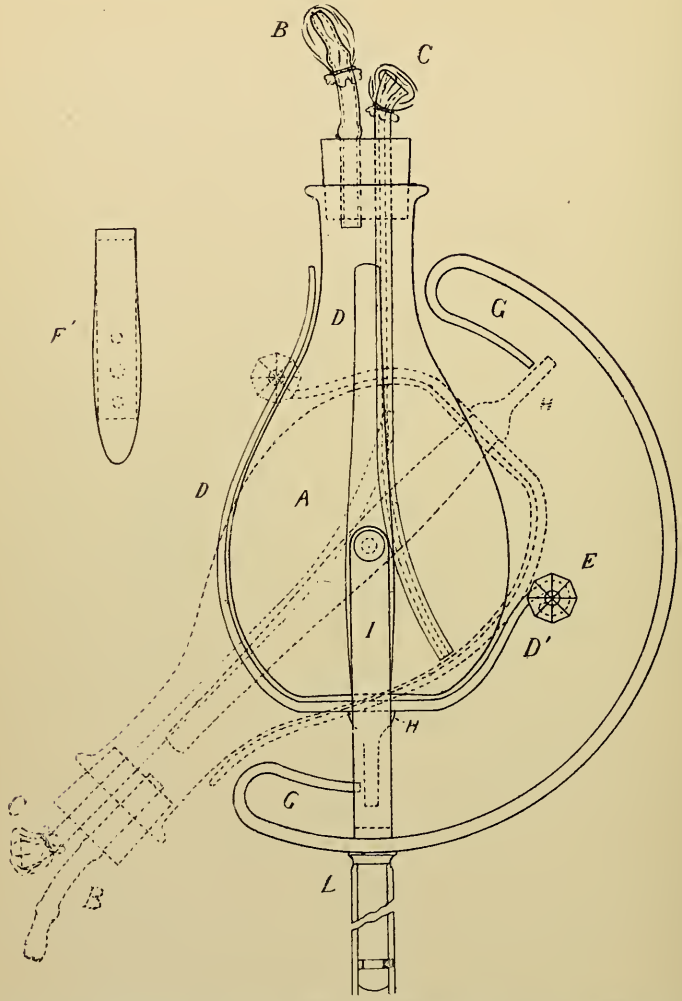

FIG. 10. — Side elevation of the holder with the handles removed for the sake of clearness. F', A: Flask holding about one and a half litres, fitted with twice-bored stopper (of rubber or cork). B: Pouring-tube with two shoulders and suitable nozzle. C: Air-tube of small internal diameter. D: The arms of the cage or basket holding the flask. D': Short arm of the cage allowing placing the bottle and also holding the counterpoise. E: Counterpoise. G: Semi-circular stop limiting the rotation of the cage and flask. H: Striker on the cage bringing up against the stop. The neck of the flask and the front arm of the cage are also limited in rotation by the stop dividing the shock and preventing breakage. I: Crutch on which the cage and flask rotate. L: Standard on which the entire structure rotates.

protected by slipping rubber tubing of suitable size over them. Thus we get in this stand an ability to place the flask

either inverted or upright, and to have it rest there in perfect security, and so joined that the whole thing can be turned in any direction, and a telescoping tube, on which the whole is supported, and by means of which it can be held at any elevation. The lower loop of the semi-circle can be used for coiling the rubber tube on, if desired.

Instead of placing this cage upon a standard, as in this figure, it may have a suspending arm attached to it, by means of which it can be fastened to any chain or cord or hook projecting downwards from the ceiling, and thus used without impairing the floor space of the operating room (Fig. 6). Or the same thing could have other fixtures, by means of which it could be attached to hospital beds for ward use, if desired.

A simpler form of stand, which answers all practical necessities pretty well, is shown in Fig. 7. The cage immediately enclosing the flask is essentially the same as that in Fig. 6, but the handles and revolving portion are omitted. Three forms are shown, one standing on the top of a pedestal, and one hanging from the ceiling, and another adjusted to hang from the head of a hospital bed, all three holding the flask in essentially the same position of inversion ready to pour, and each having a hook on its lower extremity for coiling the rubber tube, if desired.

In using this apparatus, the nurse, when irrigation is called for, takes the flask and adjusts the tube herself, inverts the flask, and begins the irrigation. After that is well started, the flask is then set in the frame and the stream regulated by the stop-cock on the rubber tube.

For the purpose of keeping these flasks of solution warm while in the operating room, a nest of four cylindrical cells or pails fitted into a water-bath answers very well.

XVII.

REPORT OF NINE CASES OF GALL-STONES.

By Francis S. Watson, M.D.

These cases occurred during the summer services of 1895 and 1896, with the exception of one in 1893.

One is not strictly speaking a case of gall-stones, but one of cancer of the gall-bladder, with extension to the liver associated with it.

For permission to report the latter, as well as for the opportunity to operate, I am indebted to the courtesy of my colleague, Dr. H. L. Burrell.

Four of the patients died. In three cases death was referable to operation, in one, which occurred two months afterward, it was due to extension of cancerous disease to other organs.

Gall-bladder excised	2 cases
(In one of these the common duct was slit up and sutured afterward.)	
The common duct was incised and drained in .	1 case
Cholecystotomy was performed in . . .	7 cases

The gall-bladder was left open and drained in all the cases.

In one a biliary fistula resulted, requiring a secondary operation for its closure, which was successful.

LOCATION OF STONES AND ASSOCIATION OF JAUNDICE.

Gall-bladder alone (cancer of liver), jaundice present	1 case
Cystic duct and gall-bladder, jaundice, 1 : without jaundice, 1	2 cases

Cystic duct alone, jaundice, 1 ; without jaundice, 1	2 cases
Cystic and common ducts, jaundice	1 case
Common duct (at intestinal orifice of), jaundice	1 case
Gall-bladder perforated, stones in gall-bladder and in mass of inflamed omentum, jaundice in both	2 cases
Total	9 cases

Case 1. — Gall-stones. Cholecystotomy. Incision of the cystic duct with immediate suture. Recovery.

A woman, aged fifty-five years. She had suffered from attacks of pain in the upper part of the abdomen — most marked in the right hypochondrium — for the past six months. For two weeks there has been severe pain in the region of the gall-bladder. Jaundice and vomiting have also been present. The stools were clay-colored. There was sharp pain and marked tenderness in the region of the gall-bladder. The patient has lost fifty pounds in weight during the last six months. The urine contains bile pigment. There is a small movable tumor to be felt in the right hypochondrium, corresponding in form to an enlarged gall-bladder.

Operation, March 10, 1893. The gall-bladder was exposed by an oblique incision below and parallel to the free border of the ribs. The peritoneum was protected by sterilized pads before opening the gall-bladder. The latter was moderately distended, and its summit could easily be brought up into the wound. It was opened by an incision through the fundus. Sixty stones were removed from the gall-bladder and cystic duct. The cystic duct was incised to allow the extraction of two of the stones which could not be removed otherwise. The wound in the duct was immediately sutured. The gall-bladder was left open, stitched to the abdominal wound, and drained. The sutures were removed at the end of the week. The stools became natural in color on the tenth day. One month after operation the patient was discharged well.

Case 2. — Gall-stones. Primary cancer of the gall-bladder, secondary extension to the liver. Resection of the gall-bladder and a large portion of the liver. Recovery from the operation. Death two months later from extension of the disease.

The patient, a woman about fifty-seven years old, was in good health until about sixteen months ago, when she had an attack of jaundice, accompanied by colicky pains in the right border of the ribs. These symptoms only lasted four days, but in the course of the next eight months she had six similar attacks, slight jaundice being associated with each one. The color of the stools was not noticed, but the urine was seen to be very dark at these times. No nausea or vomiting at any time. The last of these attacks occurred eight months ago. During the last four months the patient has lost flesh and become very anæmic.

Five weeks ago, for the first time, the patient noticed a hard bunch beneath the free border of the ribs, on the right side of the abdomen; this, she thinks, has increased somewhat in size since then. She has slight jaundice and marked anæmia. The urine is of a high color, specific gravity 1,013, with a slight trace of albumen; the sediment contains a few red blood corpuscles, hyaline, and fine granular casts. In the right side of the abdomen, and most prominent beneath the tip of the eleventh rib, there is a large, hard, slightly movable tumor, extending downwards to the crest of the ilium, and nearly to the median line in front. The dulness on percussion extends over the whole surface of the tumor, and is continuous with the liver dulness, except for a small space below the tip of the eleventh rib, which is tympanitic and is due to the interposition of a portion of the colon.

Operation, Feb. 6, 1895. A longitudinal incision, five inches long, was made through the linea semilunaris over the most prominent part of the tumor. Upon opening the peritoneal cavity the tumor was seen to consist of a much enlarged gall-bladder, infiltrated with cancerous growth, projecting beneath the margin of the liver, and adherent to its under surface, and also to two neighboring coils of intestine; the cancerous growth extended for

some distance into the liver and fused the gall-bladder into one solid mass with the lower part of the liver. The growth did not seem to extend beyond the beginning of the cystic duct, and was apparently circumscribed in the liver. The growth had pushed the lower part of the liver downward and forward against the rib, so that a deep sulcus was made in it by the pressure of its free border. The diseased mass was separated from its intestinal adhesions, and could then be brought outside the abdominal wound, after the latter was somewhat enlarged laterally. The gall-bladder and about three inches of the lower and anterior portion of the liver, including all the diseased part of the latter which was visible, was removed in three separate masses after placing three stout elastic ligatures around the base of the tumor and through the substance of the liver, beyond the disease; these were drawn tight and left in place.

There was almost no hemorrhage. The abdominal wound was partially closed, a considerable space being left open for drainage, through which large drainage-tubes were inserted, and the cavity formerly occupied by the growth was packed with iodoform gauze. The gall-bladder was tied off just above its junction with the cystic duct. It contained sixty-four small gall-stones.

The patient rallied well from the operation, and after the first four days there was a marked gain in appetite. There was entire cessation of pain during the next six weeks; there was also a marked diminution in the cachexia. She was, in fact, perfectly comfortable during this period. At the end of it, however, pain reappeared, and slowly increased until her death, which occurred at the end of the second month, owing to exhaustion due to extension of the disease into the liver and metastatic nodules in the lungs and kidneys.

Case 3. — Gall-stones. Cholecystotomy. Death.

A woman, aged thirty-seven, two months ago for the first time had a sudden and severe attack of pain in the region of the gall-bladder, accompanied by vomiting. The attack lasted five to six days. There was no jaundice. Stools

normal in color. Five days ago she had a second attack, with the same symptoms. The urine contained no bile pigment, and the stools were of normal color. A movable fluctuating tumor, about the size of the fist, could be felt in the right hypochondrium, extending downward from the lower border of the liver in the mammary line.

Operation, June 5, 1895. The tumor was exposed by a three-inch incision beneath and parallel to the free border of the ribs, and proved to be the gall-bladder greatly distended. It was opened by an incision through its apex — the peritoneal cavity having been previously protected by sterilized gauze pads — and eight ounces of viscid fluid was evacuated, two large stones were removed, one from the gall-bladder and beginning of the cystic duct, and the other from the cystic duct itself. Exploration of the common duct failed to reveal any other stones. The gall-bladder and the ducts were freely irrigated with boracic acid, a drainage tube was inserted. With the exception of the space occupied by the drainage tube, the incision in the gall-bladder was closed. Abdominal wound was also partially sutured. The patient did well for three days, and then developed pneumonia which proved fatal.

Cardiac disease (mitral valve) had been noted before the operation.

Case 4. — Gall-stones. Cholecystotomy. Recovery.

The patient, aged forty-seven, the mother of seven children, was in good health until two weeks ago, when she was suddenly seized with lancinating paroxysmal pains in the region of the gall-bladder. The bowels have not moved for one week. There has been no vomiting or jaundice. She had a similar attack one year ago, also without jaundice.

The patient is a large fleshy woman with pendulous abdomen. Her strength is good; pulse, strong and regular; temperature, 101° Fahr.

She lies with the legs flexed on the abdomen, and is in great pain.

A freely movable pear-shaped tumor of the size of the fist is to be felt in the right hypochondrium in the region

of the gall-bladder. It is connected with the liver and moves up and down with respiration.

Operation, June 16, 1895. The gall-bladder was exposed by a vertical incision in the linea semilunaris. The peritoneum was not adherent at this point. The moderately distended gall-bladder extended about four inches below the lower border of the liver. A moderate quantity of ascitic fluid was present in the peritoneal cavity. There was an area of localized peritonitis of recent date around the gall-bladder, to which were attached, by recent adhesions, a small part of the omentum and of the surface of the small intestine. The upper surface of the gall-bladder was firmly adherent to the liver.

The gall-bladder was opened by an incision one inch long through its summit. The wall of the gall-bladder was half an inch thick. There were about four ounces of thick starchy fluid in the gall-bladder, its mucous lining was acutely inflamed and bled readily. All the ducts were widely dilated. One hundred stones of the size of cherry-stones were removed by the finger and forceps. The bladder was left open and sutured to the external wound. A drainage tube was inserted. The time of operation was one hour. The convalescence was uninterrupted, the wounds healed completely one month after operation, at which time the patient was discharged well.

Case 5. — Gall-stones. Excision of the gall-bladder. Incisions of the cystic and common ducts. Closure of the latter incisions by suture. Death from shock.

A female, aged forty years. Three months ago she had a severe attack of pain in the epigastrium, radiating toward the right scapula. The pain was spasmodic. Vomiting accompanied the attack. The patient suffered from recurrence of these symptoms at intervals during the next five weeks, at which time she became jaundiced. This only remained a few days. Present attack began yesterday with the same symptoms as before. There was no jaundice, and no bile pigment found in the urine; patient was considerably prostrated; temperature, 101.4° Fahr. Tongue heavily coated. Breath offensive. Bowels have not moved for

three days. A hard mass is to be felt in the right hypochondrium in the region of the gall-bladder, extending downward to within two inches of the crest of the ilium. There is great tenderness on pressure over this area. During the next three days there were frequent attacks of pain, the temperature continued to rise, and patient's condition became serious.

Operation, June 21, 1895. The tumor was exposed by a vertical incision extending downward from the tip of the ninth rib, a large mass of greatly thickened and inflamed omentum covered the lower portion of the left lobe of the liver, and was bound to it by dense adhesions. The gall-bladder was found imbedded in this mass. Its walls were thick, and its cavity very small. Projecting from its summit, which it had perforated, was a gall-stone of the size of a large pea. An abscess containing a small quantity of cheesy material surrounded the gall-bladder. The gall-bladder was incised through its summit, and six stones of the size of that already mentioned were removed. Four others, two imbedded in the cystic duct and two in the common duct, were then removed by slitting the ducts. The latter were then sutured. The gall-bladder was excised except for a small part above the orifice of the cystic duct. The field of operation was thoroughly cleansed, a drainage tube inserted into the cystic duct, and the wound left open for free drainage. The patient died from shock twenty-four hours later.

Case 6. — Gall-stones. Localized peritonitis. Intestinal obstruction. Cholecystotomy. Recovery.

The patient is a woman thirty-six years old. Four years ago she had an attack of abdominal pain associated with jaundice. She recovered in a short time, and remained well until four days ago, when she was seized with sharp pain in the region of the gall-bladder, and noticed a tumor in the same locality. The bowels have not moved since the beginning of this attack. The abdomen is moderately distended and tympanitic. In the region of the gall-bladder there is a large pear-shaped tumor, pressure upon which is very painful. A distinct friction rub can be felt in this locality in connection with the movements of respiration.

The patient is slightly cyanotic, and much prostrated. There has been frequent vomiting during the last few days. There is no jaundice. The urine contains no bile pigment.

Operation, July 22, 1895. A transverse incision, parallel with and below the free border of the ribs, was made over the most prominent part of the tumor. The peritoneum was thickened and adherent to the gall-bladder, which was moderately distended and inflamed. Its walls were three-quarters of an inch in thickness, and its mucous lining and peritoneal investment were deeply congested. There was localized peritonitis of recent date, and numerous delicate adhesions between the gall-bladder and the coils of distended intestines in the neighborhood. The gall-bladder was opened by an incision through its summit. The gall-bladder contained a fluid of the color and consistence of thin starch. There were no stones in the gall-bladder itself. The cystic duct contained two large stones, which were faceted, the second one in such a way as to suggest the presence of another one beyond it. This, however, could not be found. It was afterward learned that the patient had passed a stone by rectum a few days previous to operation. The gall-bladder was united to the abdominal wound by interrupted sutures of silkworm gut, and a drainage-tube inserted into it.

Bile flowed through the drainage-tube for the first time on the second day after the operation. On the same day the bowels moved spontaneously. The patient made an uneventful recovery. The wound healed at the end of five weeks.

Case 7. — Gall-stone impacted at the entrance of the common duct into the duodenum. Cholecystotomy. Death.

The patient, a woman forty-six years old, has suffered from attacks of abdominal pain in the region of the gall-bladder from time to time during the past eighteen months. Jaundice has been associated with these attacks. The present attack began ten days ago. There is slight jaundice; the stools are clay-colored; there is no tumor to be felt in the region of the gall-bladder, and no marked ten-

derness anywhere in the abdomen; the pulse is weak, and the patient's general condition is very poor.

Operation, July 23, 1895. A transverse incision was made over the region of the gall-bladder parallel with the free border of the ribs. The gall-bladder was exposed without difficulty, and was to all appearance normal. It was thought that a small stone could be felt in the cystic duct by the finger. The summit of the gall-bladder was incised sufficiently to admit the finger, but no stone could be found by the most careful search of the ducts.

The wound in the gall-bladder was then united by interrupted Lembert sutures of silkworm gut, and the abdominal wound was wholly closed. There was but little shock at the time of the operation, but the patient did not recover consciousness after it, and died in about twenty-four hours.

Autopsy. There was a large single gall-stone impacted in the duodenal end of the common duct. One-half of it projected into the bowel, the other half was firmly retained within the duct, while the part surrounded by the orifice of the duct was constricted so as to form a well-marked neck between the two larger parts of the stone. The liver contained numerous small abscesses. The suture of the gall-bladder was perfectly tight.

Case 8. — Gall-stone. Cholecystotomy. Result.

A woman, aged forty-three years, in good health until within the last five months; since then she has lost strength and flesh. Five days ago she was seized with sharp spasmodic pain in the region of the gall-bladder, occasionally extending across to the other side of the abdomen. The pain is now localized about the gall-bladder, and there is a tumor to be felt in that region. It moves up and down with respiration, presents an area of dulness on percussion continuous with the liver, and has a rounded and slightly nodular surface anteriorly. It is tender on pressure. There has been no jaundice.

Operation, Sept. 12, 1896. The abdomen was opened in the linea semilunaris by an incision three inches in length over the tumor, which proved to be a distended gall-bladder with a localized peritonitis in its immediate

vicinity, and numerous delicate adhesions connecting it with a mass of omentum which lay above it, and with adjacent coils of intestine. The gall-bladder was opened upon its summit, and its contents — about four ounces of starch-like, thick fluid — were evacuated. The peritoneal cavity was protected by gauze pads previous to opening the gall-bladder. A solitary stone of the size of a small walnut occupied the lower end of the gall-bladder and the cystic duct, and was impacted in the latter. It was removed without difficulty by a curette, the common duct was examined by the finger without, and by a probe within, but no other stones were found. The gall-bladder was left open, a glass drainage tube inserted, and the abdominal wound closed around it.

There was but little shock following the operation. The patient was somewhat nauseated during the next few days. There was no pain. A free discharge of bile came through the wound. The glass drainage tube was removed on the sixth day and a small rubber drain was substituted. All drainage removed on the twelfth day. The wound healed at the end of six weeks, and the patient was discharged well.

Case 9. — Gall-stones. Cholecystotomy. Opening of the common duct. Perforation of the gall-bladder by gall-stones. Localized peritonitis. Gall-bladder atrophied.

The patient, a man thirty-two years old, has been subject to attacks of pain in the right hypochondrium in the region of the gall-bladder for thirteen years, lasting for a few days at a time. The stools were usually clay-colored at these times, and there was anorexia, headache, and malaise. There has never been jaundice associated with these attacks until the last one, which began three weeks ago. He has been deeply jaundiced during this attack. The patient is a large fat man; the skin and conjunctivæ are deeply icteric. The pain, in the region before mentioned, has been severe until six days ago, since which time there has been a decided diminution until yesterday, when it returned.

Operation, Nov. 6, 1896. The abdomen was opened by an oblique incision parallel with and a little below the free border of the ribs over the gall-bladder. A mass of

inflamed and matted together omentum of the size of the fist lay immediately beneath the wound. After separating this from its adhesions to the neighboring intestines and the under surface of the liver, the gall-bladder still could not be found. Upon separating the outer layers of the inflamed omentum a cavity only large enough to admit the first two joints of the little finger was opened, giving exit to about half an ounce of starchy fluid such as is often seen in an inflamed gall-bladder. The walls of this cavity could not be separated from the mass of omentum in which they were imbedded. Beside the mucous contents of the cavity, it contained a dozen small faceted stones varying in size from that of a millet seed to that of a small split pea. Six or eight similar stones lay at some distance from the cavity in different parts of the mass of omentum. The cavity communicated with the much-dilated common duct, and represented the remains of the shrunken gall-bladder, which had been perforated, giving exit to the stones, and causing repeated attacks of localized peritonitis, resulting in the thickened mass of omentum, and probably causing the frequent attacks of pain. The common duct was incised just below its junction with the cystic duct, and explored by a probe within and the index fingers without, through a distance of six inches. (So far as could be judged, throughout its entire length.) No stone was found in its course. A small rubber drainage tube was inserted into the duct, passed through the cavity representing the gall-bladder, and led out of the abdominal wound. The region of the gall-bladder was lightly packed with an iodoform wick, and a large glass drainage tube was also inserted. There was but little hemorrhage, but a good deal of shock.

Patient rallied well, but on the following day a severe bronchitis set in and continued for ten days, in spite of which convalescence proceeded satisfactorily. The wound, except the part left open for drainage, healed by first intention. The drainage tube was removed at the end of the first week. The jaundice had wholly disappeared on the fourteenth day. The stools became normal in color at the same time, at which time there was but a small quantity

of bile draining through the tube. Appetite was at this time also fully restored, and the patient's condition was in every way greatly improved. Whether the obstruction to the flow of bile into the intestines had been removed, during the exploration of the ducts, was not determined, but the subsequent course would seem to indicate that such was the case.

A small fistulous tract remains at the date of this report, Jan. 15, 1897.

XVIII.

THE PERMANENT OR LATER RESULTS OF FRACTURES OF THE SKULL.

By William N. Bullard, M.D.

This paper, which is intended only as a preliminary one, is the result of investigations in regard to the present condition of patients who were formerly in the Boston City Hospital with fracture of the skull. The diagnosis is taken from the Hospital Records, and in most cases was evident.

I will not enlarge on the difficulty of this investigation, except to say that it has occupied much of my time personally during portions of the past three years. I have attempted to find each patient, and have not accepted any records, except from the patient himself, or some person whom I believed fully competent to state his physical condition. Of course, very many persons were sought for who could not be found, and it was unusual when any one was found at the address given when at the hospital.

In undertaking this work I had hoped to be able to throw some light on the question as to whether the future conditions of the patient with fractured skull were better with or without operation, and under what circumstances operation was advisable. Unfortunately, the statistics obtained are too few to afford any definite answers to these questions, but they may be of value to us as making a beginning in this direction, as well as in other ways. It seems to me that hitherto our views have been influenced by general considerations, and by special conditions rather than by definite knowledge derived from a large number of carefully followed cases.

The number of patients in regard to whom information has been obtained is 70. Male adults 44, children 5; female adults 2, children 5; age unknown, 4 (3 males, 1 female).

The location of the fractures is as follows:

Base 19.
Vertex 48. Of these:
Frontal region 15; right 11, left 4.
Parietal " 19; " 9, " 10.
Temporal " 5; " 3, " 2.
Occipital " 9; " 6, " 3.
Unknown 5.

Operations — that is, trephining or some serious surgical interference — occurred in fifteen. In fifty-four there was no operation. In one it is unknown whether there was an operation or not.

The longest time which has elapsed in any case, between the time of injury and the time of examination, is forty-seven years in one case. The next longest is fifteen. In nine patients the elapsed time was between ten and fifteen years; it was between five and ten years in twenty-four patients; it was four years in five patients; three years in nine cases; two years in nine cases; one year to eighteen months in eight cases; nine months in two cases; and in two cases the time elapsed was unknown, but it was at least several years.

In estimating the results of fractures of the skull, I have not taken into account the paralyses produced at the time of injury, for these are apt to be obvious, and their duration and severity can usually be determined with some degree of probability before the patient leaves the hospital. (There were noted, however, three cases of hemiplegia.) My object has been rather to draw attention to those symptoms which, while less obvious at first, later interfere with the patient's comfort or ability to work and earn his living. I wish to consider these both in relation to the patient's condition, and also in relation to the method of treatment at the time of injury.

Out of our seventy patients, thirty-seven presented *no* symptoms due to the injury, when examined. Of these, one was examined nine months after the injury; three one year after; four at two years, and five at three years after; five between three and five years; ten between five and ten

years; and the rest more than ten years after, except for two cases in which the time was unknown, but in each it was several years.

Eight patients presented symptoms which were slight or insignificant.

Eighteen patients presented symptoms which were troublesome, but which would not prevent them from earning their living.

Seven patients presented serious symptoms.

In all the cases with serious symptoms there was mental trouble. I will mention these cases in detail:

I. Male, 48. Had fracture of the base of the skull. No operation. He seems to have been a hard drinker before the accident, but after the injury small amounts of alcohol affected him to an extreme degree, so that he would become so violent that his family were afraid of their lives, and were obliged to leave him two or three times. When not under the influence of alcohol, he was peculiar: "crazy since the injury." He died six and one-half years after the injury, of tuberculosis pulmonum.

II. Male, 26 years old when injured. Is now at the State hospital for dipsomaniacs at Foxboro', seven years after injury. He had been a hard drinker for some years previous to injury, and has continued to be so since. His mental symptoms are melancholy and hallucinations of sight and hearing. It is entirely doubtful whether they are connected with the injury, which was in the left frontal region. There was no operation.

III. Male, 10 years old at time of injury. Fracture in right frontal region. No operation. It is now fifteen years since the injury. He is said by his mother to be peculiar; is "hasty," and probably at times rather violent. Is not addicted to alcohol, but if he takes any shows its effects more quickly than natural. Has never been the same since the accident. Has a sister who is insane, and her insanity is attributed to the same accident. Is a plumber, and able to work.

IV. Male, 50. Fracture of left parietal. No operation. Thirteen years after injury. Wife states that he has never been the same since the accident, has been less active

minded. Was stupid for a time after leaving the hospital, but gradually improved. No headache, vertigo, deafness, or tinnitus. Is at work; is a laborer.

V. Male, 55. Laborer. Fracture of left parietal. No operation. Became childish after accident. Was unable to work for a year and died three years after injury, of chronic bronchitis.

VI. Female. Adult. Age unknown. Fracture of base. No operation. After injury her mind was affected. Was melancholy, and would sit all day doing nothing. This person was probably alcoholic.

VII. Male, 12. Fracture of base of skull. Hemorrhage from right ear. Eighteen months after injury is slightly deaf. No tinnitus. Has headache and dizziness at times. Cannot learn at school since the injury.

The symptoms in the second of these cases are undoubtedly due to alcohol, and those in the first and sixth probably so, at least in part. In the third case there was an undue excitability of moderate severity, while in the fourth and seventh we find the opposite, an abnormal mental slowness or stupidity and an inability to learn. In neither of these two last adults (III. and IV.) were the troubles severe enough to prevent them from working. In the remaining case the patient was said to have become childish.

The only other case where severe symptoms, other than paralysis, were recorded was that of a man seen forty-seven years after a fracture of the right frontal, which had occurred when he was eight years old. He had convulsions daily for a time, but had had only one during the past twelve years. He presented himself at the hospital on account of a posterior sclerosis of the spinal cord, not connected with his injury.

The symptoms most frequently found after fractures of the skull in our cases are, however, headache, vertigo, deafness, and a condition of the brain which shows itself by the extreme susceptibility of the patient to the effects of alcohol. This latter condition is probably present in a large proportion of cases, although not always mentioned.

Headache occurred in twelve, not counting one in which it was noted as rare and another in which it was not com-

mon. As a rule it is not severe or troublesome, and does not interfere with work. In two of the cases counted the patients were alcoholic, and it was doubtful how far the injury was the cause of the pain. In three cases the headache was unilateral and on the injured side of the head.

The only case in which the headache was troublesome was that of a man fifty years old at the time of injury, who had a fracture of the posterior parietal region and of the base. The examination was made fourteen months after injury. He was deaf and troubled with dizziness, and had a constant diffused headache. He was probably alcoholic, so that the cause of the headache was not certain.

In only one of the cases in which headache occurred had an operation been performed, and even in this case the cause of the headache was doubtful. The injury, which was a fracture of the anterior portion of the left parietal occurred in a girl six years old. Some fragments of bone were removed, and depressed bone elevated immediately after the injury. She was seen nine years later. Her family circumstances had been unfortunate and her inheritance poor. She had been subject to attacks of violent excitement or anger. Three months previous to my visit her headaches ceased with the appearance of the catamenia.

Dizziness or vertigo was found in thirteen cases, and in one other it was reported as having existed for two months after leaving the hospital and having then ceased. In three cases it was noted as slight. In one it was unilateral. In two cases it existed in company with tinnitus, and in five cases in company with deafness. Curiously the tinnitus and deafness were not found in the same cases.

Too much stress cannot be laid on the location of the fractures in cases which are not examined post-mortem, because it is often impossible to determine where the cracks and fissures extend, and it is impossible to exclude other fractures than those noticed. In the cases of headache four of the fractures were of the base, four of the frontal, and three of the parietal regions, while one was in the region of the posterior fontanelle. Of the doubtful cases one was a fracture of the base, one of the frontal, and one of the parietal regions.

In the cases which suffered from vertigo two of the fractures were in the frontal region, five in the parietal, one in the occipital, and six were of the base. In none of these cases had any operation been performed.

Deafness was found in nine cases, in two of which it was noted as slight and in another it was said to be diminishing. In one case it was bilateral. In four it coexisted with headache, and in five with dizziness: in every case where there was deafness and headache there was also vertigo. Thus there was only one case in which there was vertigo and deafness without headache. The seat of fracture was at the base or in the bony wall of the ear in six cases; in two it was seen in the occiput; and in one the fracture was in the frontal region. As mentioned above, the site of fracture found during life does not show the real extent of the injury. We should naturally expect deafness to occur principally in fractures of the base, or in such as involved the petrous portion of the temporal bone. In only one of these cases was an operation performed at the time of injury.

Tinnitus was not complained of in any of the cases in which there was deafness. It occurred only twice, and both times in company with dizziness. There was no operation in either of these.

In three cases a sensation of drawing or pulling in the wound was complained of, and this occurred chiefly when the head was in such a position as to cause the brain to sink away from the wound. Two out of the three complained of it especially at night, and said that it kept them awake. This symptom is probably more common than would appear from these statistics. Many of those who have it to a slight degree do not mind it much, and do not speak of it. There was no serious operation in any of these cases; in one some loose bone had been removed.

One of the above cases also complained of a sensation about the wound as if a piece of leather were tacked over it. One patient, who had also headache, complained of a "funny feeling about the head" for some time after the injury, which, when seen seven years after the injury, was slight and not troublesome.

CONCLUSIONS.

I. Out of seventy persons with fractures of the skull thirty-seven presented no symptoms when examined some time later.

II. Seven persons only presented serious symptoms, and in at least four of these it is doubtful whether the symptoms were due to the injury.

III. The most frequent consequences found were headache, deafness, dizziness, and inability to resist the action of alcohol in the brain.

IV. Out of the fifteen cases in which operation (trephining, etc.) was performed, twelve had no symptoms; in another it was doubtful whether the symptoms present were due to the injury; in another the symptoms were slight (headache rare, tension over wound while lying in bed). The other was deaf, but had no other trouble. We are justified, therefore, in concluding, so far as our statistics lead, that those cases in which trephining was performed have shown much better results as far as the symptoms discussed are concerned than those in which no operation was performed.

XIX.

BURSITIS OF THE DEEP PRETIBIAL BURSA, WITH A REPORT OF CASES.

By Robert W. Lovett, M.D.

A bursa of considerable size lies beneath the ligamentum patellæ. Its existence has been for a long time recognized in most text-books and treatises on anatomy,[1] and it is indicated, almost always incorrectly, in diagrams of the knee-joint. Anatomically and surgically it has received but little attention, and no one name has been given to it, for it is so little known that each writer who has mentioned it has called it what he chose.

As a matter of identity, some of its names, at least, must be mentioned:

Bursa (mucosa) infragenualis. Koch.
Bursa ligamenti patellæ. Soder.
Bursa de capsule inferieure de genou. Lauth.
Bursa infra patellaris profunda. Gruber.
Bursa ligamenti patellæ posterior. Gruber.
Bourse sous rotulienne profond. Poirier.
Bourse propre du ligament rotulien. Poirier.
Bourse sous ligamenteuse. Follin et Duplay.
Bourse prétibiale. Dubrueïl.
Subligamentous bursa of the knee.
Deep pretibial bursa.

By the kindness of Professor Dwight the writer was enabled to study this bursa in 48 knees in the dissecting room of the Harvard Medical School, as well as in some wet preparations of the knee. In one knee ankylosis was present, and it was of interest to note that no trace of the bursa, as such, could be found. The ligamentum patellæ was apparently applied directly to the tibia in this case. In the 48

[1] Fourcroy, Mem. de l'Acad. de Med., 1787, p. 291.

cases observed, the cavity of the bursa was always smooth and unilocular. There were no trabeculæ present, and the shape and position were practically constant. The amount of fluid contained varied, but this was probably more affected by the amount of moisture in the subject than by any other cause.

The boundaries of this bursa are as follows:

Above it rises to the level of the front part of the articular surface of the tibia, and the upper line of the bursa is parallel to and level with that. Its relation to the pad of pretibial fat, which lies behind the lower surface of the patella, varies. Often the lower edge of the fat hangs as a curtain into the bursa, sometimes for half an inch. In these cases the bursa extends up behind and in front of the lower part of the pad of fat. More often the bursa extends up in front of the pad, which in the latter case lies against the tibial surface.

Posteriorly the bursa lies closely on the periosteum of the tibia.

In front it is in contact with the under surface of the ligamentum patellæ. It is as wide as the ligament and in some cases a little wider. When distended it is obvious that its only expansion must be at each side of the ligament. The patella tendon is inserted obliquely into the tubercle of the tibia much lower down at its outer than at its inner border. Consequently the lower border of the bursa, which is determined by this insertion, is oblique, also sloping downward and outward. The inner vertical border of the bursa is much shorter than the outer vertical border. As a result of this, the bursa is approximately triangular in shape.

Although it is sometimes[1] asserted that this bursa may communicate with the knee-joint, it is obvious, on dissection, that this is not likely to be the case. Its upper level reaches nearly to the joint, but it is separated by a thick pad of fat in all directions, from the synovial membrane. The bursal cavity is always well defined, and only

[1] Scrachley, Thèse de Paris, 1839. Tillaux and Panas, quoted by Dubrueil. Annales d'orth., Sept. 1, '90, p. 323. Villermé, Blandin, Velpeau, quoted by Gruber. Die Knie Schleimbeutel, Prag, 1857, p. 10. Cruvelhier, quoted by Poirier, 1886, 17, 7me Serie, 705.

superficial dissection could favor the idea of communication. Poirier, in 300 knees examined, found no connection. Gruber, in 600 knees, found communication once by a well-marked canal. Ulcoeq examined 20 knees without finding a case of communication. Dubrueïl examined 30 knees without a positive result: Feraud 16 knees with similar conclusions: and Bouquet[1] 12 knees. Therefore, in about 1,000 knees examined in this regard communication with the synovial membrane existed once only.

On the skin the bursa may be mapped out as follows: It should reach to the anticular surface of the tibia above, and below to the lower half of the tubercle. At the outer edge of the ligament it extends to the lower part of the tubercle. Laterally it should not project beyond the ligament, nor should it fill out the hollows on both sides of the ligament, which are most evident in semiflexion of the knee.

Cases where inflammation of this bursa have been reported are few.[2] Trendelenburg describes some cases under the name of Hygroma infra patellare profundum.[3] Dubrueïl[4] would speak of the affection as "Pseudoarthrose du Genou." Follin[5] and Duplay speak of "Hydropsie" of the bursa placed beneath the ligamentum patellæ, and Heineke[6] and Pitha[7] also speak of the affection, although the latter had never seen a case. Feraud reports five cases.[8] There are other occasional references to the affection.[9]

The writer would report five cases, all of mild grade, and can recall several others seen from time to time where the affection was not recognized by him, but where inflammation of this bursa probably existed. It cannot be a very uncommon affection.

The *symptoms* of inflammation of this bursa are as fol-

[1] Bouquet, Thèse de Paris, 1864, No. 183, p. 23.

[2] Roswell Park; operative case; man 40 years old; 1 year duration. Internat. Clinics, 4th series, II., p. 153.

[3] Archiv. fur klin. Chir., 1877, XXI., p. 132. Two cases reported; not operated.

[4] Annales d'orthopedie, Paris, September, 1890.

[5] Traité de Pathologie externe, III., p. 19. The pathology apparently differs in no way from that of the affections of other bursæ.

[6] Heineke, Anat. & Path. der Schleimbeutel, etc., Erlange, 1868, p. 108.

[7] Pitha and Billroth, Chirurgie IV., I., Heft 2, p. 242.

[8] Feraud, Thèse de Montpellier, 1880.

[9] Edw. Scrachley, Thèse de Paris, 1839, No. 34.

lows: Pain and stiffness in walking, especially in going upstairs. Pain on extreme flexion of the leg, and especially pain in complete extension referred to the ligamentum patellæ. The latter is so marked that the patient generally walks on the toe of the affected leg. The tubercle of the tibia is more prominent than normal and appears to be thickened. The ligamentum patellæ is tender, especially at its insertion into the tubercle, and is more prominent than usual. On examination it is seen that at each side of the patella tendon there is a bulging prominence which fluctuated in the severer cases. This is due to the distended bursa. Semiflexion of the knee makes this more evident. The patella does not float unless synovitis of the knee is also present.

The *diagnostic* points are these: Pain and tenderness referred to the patella tendon, especially to its outer aspect. Apparent enlargement of the tubercle of the tibia. Severe pain chiefly in complete extension of the leg, especially against resistance. Prominences instead of hollows on both sides of the ligamentum patellæ in semiflexion of the knee.

These points will serve for its differential diagnosis from other affections of the knee-joint.

The affection most likely to be confused with it is inflammation of the superficial pretibial bursa, of which cases have been reported by Monks and M. H. Richardson;[1] but in these cases the swelling lies anterior to the ligament. The inflammation of abnormal bursæ in this situation may also be mistaken for this affection, as was demonstrated by Delore.[2]

In all the cases seen by the writer the progress has been unwarrantably and discouragingly slow, much more so than in a synovitis of the knee of apparently the same grade.

The *treatment* has been fixation as complete as possible, preferably by a ham splint or by plaster of Paris, until tenderness has nearly disappeared and until complete flexion can be accomplished without pain. Then the splint has been gradually discontinued and a flannel bandage substi-

[1] Boston Med. & Surg. Journal, Dec. 18, 1890.

[2] Gaz. Hebdom. de Med. et de Chir., June 2, 1894, p. 255.

tuted for it. Massage has been of benefit in the later stages, but in one case did harm during a subacute condition. More serious cases than those described might demand aspiration or incision.

Case I. — The first case recognized was Feb. 28, 1891. Clara J. P., twelve years old. Came to the Children's Hospital complaining of trouble in the right knee of four weeks' duration. No cause was known. The symptoms complained of were pain and catching, and inability to extend the leg fully. Flexion to any marked degree was painful. There was no effusion in the joint. The tubercle of the tibia was apparently enlarged and the ligamentum patellæ was tender. A ham splint was applied, and iodine was used. April 7, flexion to a right angle was permitted. April 21st, nearly three months after the beginning of the trouble, the knee was apparently well and treatment was discontinued.

Case II. was seen at the City Hospital, and was in a girl of the same age and almost identical with the one reported above.

The case is reported only from the writer's recollection, but the duration was similar to that in Case I. and the treatment was the same.

Case III. — A lady of forty-five, with beginning rheumatoid arthritis, fell from her bicycle, striking the front of her left knee. She rode several miles after this without very much suffering. The next day she was unable to extend the leg fully, and the knee felt stiff. She stayed most of the time in bed, and each time after a rest was better; but going upstairs was very uncomfortable, and she walked mostly on her toe on account of the persistent pain in straightening the leg. Three weeks after the accident she consulted the writer. There was no acute synovitis of the knee, as shown by floating patella or thickened joint sac. The deep pretibial bursa bulged out slightly on each side of the tendon of the patella. Tenderness and apparent enlargement of the tubercle were present.

As the affection was manifestly much better and improving, and as it was not practicable for the patient to wear a

splint, a stout flannel bandage was employed along with iodine and enforced rest. After five weeks of this, and eight weeks after the accident, recovery was nearly complete and the limp scarcely perceptible. The last symptom noticeable was pain in fully extending the knee; pain in extreme flexion was at no time a marked feature in this case. Massage proved of benefit in the latest stages of the affection.

Case IV. — A surgeon contracted a synovitis of the right knee. No cause could be found, and after a week of going about on it he submitted to a plaster cast, and on recovering from the joint effusion he found the deep pretibial bursa distended and creaking on flexion. It persisted long after the synovitis was well, and creaking in the bursa still exists after two years. He had not at any time pain in either the joint or bursa.

Case V. — A doctor of thirty-five, unusually well-developed and a trained athlete, fell in March, 1896, slipping on a piece of ice and striking his knee. He had what appeared to be a slight synovitis which caused much swelling, but he had no treatment beyond bandages and liniments and kept about his work. In three or four weeks the knee was practically well. In May, however, when he began to ride his bicycle, he found that complete extension and extreme flexion were both painful after a long ride. He gave up bicycling and limped for a few weeks. In July he went to the seashore and played golf, tennis, etc., but the knee was a little troublesome, and about the first of August he slipped in a wet tennis court and was compelled to give up active exercise.

He consulted the writer Sept. 8, 1896. He walked with the knee flexed and limped markedly. He had no apparatus on the knee and complained chiefly of the pain in complete extension. There was a slight synovial effusion, but the joint sac was not thickened, and symptoms of synovial inflammation severe enough to cause the disability were lacking.

Pain in movement was referred to the tendon of the patella. It was tender, and there was a slight fluctuating

swelling on each side of it. The tuberosity was enlarged and tender. The diagnosis of bursitis of the deep pretibial bursa was made along with a slight degree of synovitis and a plaster bandage applied. Pain disappeared at once, the effusion absorbed in the joint, and the local symptoms improved. Fixation was continued for nearly three months, until it was possible for the patient fully to extend the knee against resistance without pain. It is interesting to note that during the summer the patient, on his own responsibility, tried massage, which only served to make matters worse.

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XX.

A CASE OF AMŒBIC ABSCESSES OF THE LIVER, WITH AUTOPSY.

By John C. Munro, M.D., and Wm. T. Councilman, M.D.

Patrick C., an Irishman, 47 years old, entered the hospital on August 27, with the history that two weeks previously, during a very hot spell of weather, he was overcome by the heat while at work shovelling coal at one of the wharves. He was unconscious for four hours, and at first was attended only by his friends. Later, owing to almost constant nausea, with occasional vomiting, diarrhœa, and moderate epigastric pain, the dispensary physician who was called in treated him for his bowel trouble. He kept in bed most of the time until his admission to the hospital. At entrance he looked markedly typhoidal, having a high temperature, a pulse of about 90, a dirty dry tongue, and mental apathy. Nothing abnormal was found in his heart or lungs, but in the abdomen in the upper middle quadrant a round, prominent, tensely fluctuating tumor could be seen and felt extending from an inch or two above the umbilicus to the ensiform cartilage, and laterally to the nipple line. The upper line of liver dulness was one to two spaces lower than normal, and the splenic area was separated from the tumor by a resonant strip.

On August 29, under ether, a two-inch median incision was made over the centre of the tumor. The thickened peritoneum was adherent to the cyst-wall in all directions for an inch or more. On opening the latter, a thick, greenish-yellow fluid of sweetish odor and containing cream-like clumps escaped. The inner surface of the cyst-wall posteriorly was roughened, thick, and with moderately tough broken-down projections: inferiorly the wall felt very thin, while above and to the right the cavity apparently occupied the place

of the lower portion of the liver. There was moderate oozing as the cyst contracted. After irrigation and removal of a piece of the wall for examination, the much-shrunken cavity was packed with iodoform gauze and a glass drainage tube.

The patient stood the operation well, and on the following day (August 30) the temperature had fallen to normal, vomiting had ceased, and he felt much better.

For six days the temperature remained normal, and the patient gained steadily until the seventh day, when the temperature rose in the afternoon, he began to vomit freely and frequently, and diarrhœa developed.

On the eighth day the stools contained blood, abdominal pain and hiccough appeared, and he became dull and stupid. The wound remained clean, and continued to secrete the same substance as at first.

On the ninth day he was worse, the typhoidal stools continued, and bile escaped from the wound. The face grew pinched and white, and he was steadily failing.

On the tenth day, the diarrhœa being accompanied at times with much blood, the patient rapidly lost ground, and died at 9.45 P.M.

The urine examined at entrance showed nothing of importance beyond albumen in small quantity.

After his death endeavors were made to obtain some clew as to where the patient could have acquired the amœbæ. His friends and a fellow-laborer insisted that he had not been away from Boston for over ten years. Although at work discharging coal vessels, neither he nor his fellow-laborers probably ever drank the warm cask-water aboard the vessels, although, of course, it is possible that he may have done so. A few weeks before his attack he had worked at digging on one of the large reservoirs near the city. Beyond this it was impossible to follow up his whereabouts with accuracy.

Autopsy Sept. 9, at 11 A.M., by Dr. Councilman:

The body that of a man about 50 years old, rather small, slightly built, greatly emaciated. Body length, 171 cm.

In the anterior abdominal wall, in the median line, commencing close beneath ensiform cartilage, and extending

downward a little to the right side, is an incision 6 cm. long, closed by fine sutures. Subcutaneous fat slight in amount. Muscles dark; abdomen retracted.

Heart, wt. 340 gms. The pericardium in one place firmly adherent. The myocardium rather dark. Valves normal. Coronary arteries normal.

Aorta normal.

Both lungs free from adhesions, save along diaphragm, where there are slight, easily broken-down fibrinous adhesions. Both lungs in high degree emphysematous; very dark in color from coal pigment. Bronchi slightly dilated, pale; otherwise normal.

Before opening abdomen, slight induration could be felt in left hypochondrium. On opening abdomen, the incision in abdominal wall is found to pass into a sac on the lower border of the liver. The transverse colon is adherent to the anterior abdominal wall, shutting off the peritoneal cavity below. The small intestines are slightly agglutinated to one another, and in places between the folds, and especially toward the root of the mesentery, there are masses of gelatinous-looking fibrin. The same gelatinous-looking fibrin extends down into the pelvis. There is an abscess cavity which extends along the left border of the liver, between that, the colon, the stomach, the spleen, and the abdominal wall. This abscess cavity is filled with a grayish, more or less tenacious, fibrinous, gelatinous pus. Along the hepatic side of the transverse colon there is an abscess communicating with the first abscess by a small opening, and which is filled with a yellowish purulent material. There are several large openings from the transverse colon into this abscess. All of the tissues in the vicinity appear to be more or less softened, as though from the action of gastric juice.

The liver is not enlarged. On the anterior lower border of the liver there is a large sac which extends directly into the liver, and which is continuous with the incision in the abdominal wall. This sac is filled with a rather thin yellowish material. Its walls are deeply stained with bile. On section of the wall there is everywhere a hard, fibrous limiting membrane. In a few places there are pockets filled with the gelatinous pus described before, which extend from the

abscess wall into the liver. This abscess cavity measures 8 × 6 cm.; its walls almost in apposition.

In the lower border of the left lobe of the liver there is a small area 10 × 8 cm., which is covered with a shaggy gelatinous-looking mass. There is no outer wall to this cavity. It forms part of the large abscess before described. It extends for a considerable distance into the liver, and on the liver side is lined with a fibrous capsule.

On cutting into the liver in the middle of the right lobe there is an abscess cavity 4 × 3 cm. in diameter. This presents on section a granular reticular-looking mass, yellowish and necrotic, and in the meshes of the reticulum there is thick, gelatinous-looking pus. This abscess cavity is not very sharply circumscribed, but the necrotic tissue extends directly into the liver. On the upper surface of the liver, between that and the diaphragm, there are fresh, easily broken-down adhesions, composed of gelatinous fibrin. The bile ducts are dilated.

The spleen, wt. 135 gms. Dark: its capsule wrinkled and covered with a gelatinous, fibrinous, purulent mass. The spleen forms part of the abscess cavity first described.

The mucous membrane of stomach somewhat hyperæmic; otherwise normal. The duodenum normal.

The large intestine throughout contains numerous ulcers. Beginning at the cæcum in the ascending colon the mucous membrane is swollen, thickened, gelatinous, and here and there in it there are small circular undermined ulcers, the largest of them 1½ cm. in diameter, with gelatinous purulent infiltration of the submucosa extending for some distance around. In the transverse colon the lumen is dilated, the mucous membrane is thickened, and everywhere there are large ragged ulcers covered with gangrenous black sloughs; the surrounding mucous membrane where it is preserved is thickened; the submucosa infiltrated. The intestine contains a yellowish, rather thick, more or less viscid material. There are several large openings from the deeper ulcers into the peritoneum.

Kidneys, combined wt. 360 gms. Capsule peels off easily. Cortex and pyramids normal. Markings somewhat obscure.

Adrenal glands and pancreas normal.

Pelvic contents normal, with the exception of rectum, in which similar ulcers to those in the ascending and descending colon are found.

ANATOMICAL DIAGNOSIS.

Multiple amœbic abscesses of liver. Circumscribed amœbic peritonitis from perforation of liver abscess. Operation wound into abscess of liver. General fibrino-purulent peritonitis. Amœbic dysentery with perforation. Emphysema of lung. Anthrocosis of lung.

The microscopic examination of the contents of the abscess of the liver and of the intestine shows large numbers of vacuolated amœbæ, in some instances containing red blood corpuscles. Movement could be made out in but few of these. Amœbæ were also found in the gelatinous examination in the general peritoneal cavity.

CULTURES.

Blood and exudate in general peritoneal cavity is sterile. In liver and spleen, numerous liquifying organisms and staphylococci. In kidney, colon bacilli.

MICROSCOPIC EXAMINATION.

Sections of the intestine showed numerous ulcers varying in extent. Some of the ulcers pass down into, and in places through, the submucosa. Others are more superficial. In some places the intestine over quite a large area is ulcerated and the edges of the mucous membrane are greatly undermined. The ulcers and undermined edges of the intestine contain pus. The submucosa is infiltrated with pus and fibrin. In places the connective tissue cells are enormously swollen. The cellular infiltration extends in places into the muscular coat and between the circular and longitudinal fibres. There is more or less degeneration of the muscular tissue beneath the ulcers. Amœbæ are found in almost all of the sections, but in varying numbers. Where the sections pass through the mesenteric attachment in some cases fibrin is found extending down into this. No amœbæ are found in this situation. In one place intense cellular

infiltration is found in the fat of the mesentery where it adjoins the intestine, but there are no amœbæ in this.

The peritoneum over the affected intestine is in places greatly thickened, and amœbæ were found on the peritoneal surface.

Sections were made in various places through the abscess of the liver. All of these showed the well-known conditions of amœbic abscess. Remains of portal liver tissue throughout the abscess everywhere, and softening of the tissue between. Amœbæ were found in the liver abscess, but they were not very plentiful. Usually when found they were larger than those in the intestine.

Sections made completely across the most recent abscess, that in the right lobe, were perfectly typical. There was a mesh-work of liver tissue extending throughout the abscess with softening in between. Amœbæ were not plentiful in this abscess, but were present. There are large numbers of pus cells, but most of the tissue of the abscess seems to be made up of necrotic liver tissue. In places in the mesh-work of material in the abscess typical granulation cells are found.

Blood corpuscles were found enclosed in the amœbæ in a few instances. The abscess in the lower edge of the liver into which the external incision opened was lined with dense fibrous tissue, save where fresh extensions passed into the liver. No amœbæ were found in the main abscess, but a few were seen in sections involving the fresh extensions.

This case is interesting in showing the extent and variety of the lesions caused by the amœbæ, and very well illustrates the character of lesions. There can be little doubt that the lesions in the intestine were primary, and nothing can be known as to their duration. Infection of the liver took place, forming the abscess on the lower surface, which was opened into and drained. The large peritoneal abscess, which involved the left lobe of the liver, the stomach and spleen, was due to another abscess which opened in the peritoneal cavity. One side of this liver abscess seemed to have been completely destroyed, the other forming part of the cavity. The perforation of the intestinal ulcers with the formation of a second abscess along the transverse colon

and the lower border of the liver must have taken place very shortly before death. How well these abscesses were shut off from the general peritoneal cavity is shown by the sterility of the cultures made from the exudation in this, the direct examination showing amœbæ, but no bacteria. Attention is also directed to the situation of the older liver abscesses. They were on the lower border of the liver where the hepatic flexure of the colon may come in contact with it. The most frequent situation of the amœbic abscess is here and on the upper surface of the right lobe close beneath the diaphragm. These situations point to a direct infection from the intestine or from the peritoneal cavity, and not by the blood. There is, however, no doubt that infection can take place in both ways, as is shown by the multiple small abscesses which are sometimes seen.

The lesions produced by the amœbæ differ from lesions produced by any other infectious agent, and consist rather in necrosis followed by liquefaction of the tissue than pure suppuration. In the intestine the amœbæ make their way into the loose connective tissue of the submucous coat, and the necrosis and softening of this in some cases seems to precede the destruction of the mucous membrane. The finding of the amœbæ in the sections was greatly facilitated by the use of a method suggested by Dr. Mallory.

1. Harden tissues in alcohol or corrosive sublimate.
2. Stain sections in a saturated aqueous solution of thionin for five to ten minutes.
3. Place in a two per cent. aqueous solution of oxalic acid for one minute.
4. Wash off in water.
5. Dehydrate in alcohol.
6. Clear in bergamot or origanum oil.
7. Wash out oil with xylol.
8. Mount in Canada balsam.

The nuclei of the amœbæ and the granules of mastzellen are stained red. The nuclei of the mastzellen and of all other tissue cells are stained blue.

XXI.

NOTES ON HEART EXAMINATIONS IN SURGICAL PATIENTS.

By John C. Munro, M.D.

During August and September an endeavor was made on the First Surgical Service to examine as thoroughly as possible all patients undergoing operation, to determine what effect, if any, the operation had upon their hearts. Records of the size, apex beat, presence or absence of murmurs, and of the quality of the heart-sounds in each patient were made before and after operation, and when necessary repeated examinations of the same case were made.

All credit is due to Mr. W. G. Adams of the fourth-year class of the Harvard Medical School, who persistently and patiently carried on the work. Where desired, his results were corroborated by the writer and others.

Naturally all the patients could not be examined, but enough of interest to the writer was obtained to make it seem worth while to place the results on record. Most of the patients were examined two, three, or twenty-four hours before and twenty-four or forty-eight hours after operation, which in most instances was of a serious nature.

In two only of the fifty-seven operative cases examined did cardiac signs, not previously existing, develop after operation. In one a distinct, soft, short murmur was heard, replacing a small portion of the first sound, and loudest a little above and to the outside of the apex. The operation was a long (seventy minutes) and unusually difficult one, for pyosalpingitis and appendicitis; the patient apparently stood the operation well, and but little ether was used.

In the other case an exploratory laparotomy lasting only twelve minutes was performed for intense jaundice, pain, and high fever, due to hypertrophic cirrhosis of the liver. The cardiac signs that developed three days later consisted

in a double murmur at the pulmonic area, probably hæmic. The patient left the hospital later in good condition, and without evidence of further trouble.

In twenty cases the heart was normal before and after operation, which varied in severity from excision of a nail to ruptured tubal pregnancy, the majority, however, being serious. To these it is fair to add four major emergency operative cases, in which, although no examination could be made beforehand, normal hearts were found after operation.

Fourteen patients had abnormal cardiac signs that persisted after operation. Five women and one man probably had functional disturbances, but the remainder, five women and three men, had well-marked organic lesions. So far as could be seen none of these was the worse for the experience.

There were three fatal cases where no examination could be made after operation, but no heart lesions had been detected beforehand. As the operations were all severe — trephining for acute ependymitis, laparotomy for cancer of the pylorus, and for general peritonitis — it is not presumable that the results were due to obscure heart lesions not recognized.

An interesting group consisted of patients in whom there was evidence of cardiac disturbance before operation, all signs of which disappeared as soon as the operation was over. It included seven women and four men, and in the latter the operations embraced a circumcision in a very nervous young man, a gastrostomy in an intelligent patient who realized the gravity of his condition, a radical operation for hernia, and cautery of an anal varix where cocaine instead of ether was used. The gastrostomy had a presystolic murmur; the others, a systolic murmur at the apex.

Among the women the operations varied from one of minor degree to a thyroidectomy; some were markedly nervous, but all were not so, judging, at least, from their appearance and behavior. In a case of exploratory laparotomy, the patient being very hysterical, there was a systolic basal murmur previous to the day set for operation; this was postponed and the murmur vanished in two or

three hours, only to reappear on the following day an hour or so before the ether was given, and then as promptly disappearing on completion of the operation. The signs in these nervous patients were more or less distinct murmurs at the apex or base, or over the general cardiac area. Besides these presenting a murmur, there were three women showing evidences of a nervous heart by rapid, irregular action, with, perhaps, an accentuated pulmonic second sound.

In addition to the operative cases fifty-six patients not requiring operation (fractures, head injuries, etc.) were examined as a matter of curiosity. Forty-four had no cardiac lesions, three had well-marked valvular disease, and one had serious enlargement, while eight had a soft systolic rub at the apex or base, that was probably, though not necessarily, hæmic in character. One of the mitral cases was interesting, from the fact that his normal pulse was thirty beats to the minute, and his temperature was subnormal. The pulse rose to one hundred and twenty during occasional epileptiform convulsions, only to resume its normal rate as soon as the attack ceased.

The inference to be drawn from these few cases is that the usual valvular lesions are not necessarily affected by surgical operations, and that a soft murmur, especially in women, will frequently disappear after operation and need cause the surgeon no anxiety.

XXII.

INJURIES TO THE RADIAL SIDE OF THE WRIST-JOINT.

By Edwin Welles Dwight, M.D.,

Surgeon to Out-Patients, Boston City Hospital; Assistant in Clinical Surgery and Legal Medicine, Harvard Medical School.

Among the many cases of surgical interest that are commonly seen in the "Out-Patient Departments" of our larger hospitals, there are few if any that are of more interest or importance than injuries to the wrist-joint.

Especially is this true of those which involve the radius, or in which fracture of the styloid process of the radius must be seriously considered.

There is a large amount of literature on the subject, and the names that have been given to the various fractures of the lower end of the radius are so numerous as to be perplexing, particularly if any attempt be made to follow them in the hurry of an out-patient clinic, where from one hundred and fifty to two hundred and fifty patients are treated during the morning hours.

The working rule that "for purposes of treatment no such thing as a sprain of the radial side of the wrist exists" is a most valuable one, and if followed a large number of poor results would be avoided.

Sprains of the radial side of the wrist do exist, however, as do other cases in which the diagnosis of fracture cannot be made, either with or without the aid of ether, but in which the symptoms and duration of disability closely follow those of fracture.

The frequency with which these cases occur and the undesirability of classing them either with fractures or sprains has caused me to adopt for out-patient purposes

the term "radio-carpal synovitis," and to divide injuries to the radial side of the wrist-joint as follows:

Reserving the title of "fracture of the radius" for those fractures which involve the radius more than two inches above the tip of the styloid process, all other fractures which can be demonstrated are called "Colles' fractures." These include a few which are more than one and a half inches above the articulating surface as described by Colles.

The second class, that of "radio-carpal synovitis," includes without doubt a very considerable number of fractures, but they are those in which none of the physical signs of fracture can be discovered, and where something more than the ordinary sprain must be considered in order to account for the symptoms and their duration.

The following case will illustrate those which are included under this name:

Charles B., 24 years old. Clerk. No previous accident. Says that while walking on the sidewalk he slipped and fell. His right hand was extended to save himself. He does not know just how he struck the sidewalk. At once had severe pain in right wrist shooting up the arm.

Appeared the next morning for treatment.

Physical Examination. — Healthy, muscular young man, *right wrist*, slight swelling of wrist, sharply localized between the tip of radius and scaphoid. Here the swelling is tense and gives the impression of fluid in the synovial sac.

Pressure at this point causes great pain. Pressure over scaphoid and styloid process gives some pain, but decidedly less than over joint. No deformity, no shortening, no thickening either of radius or scaphoid.

No tenderness over ulnar or other portion of joint.

Ether was given as a precautionary measure, but nothing further was made out.

Attempts at the reduction of impaction yielded nothing.

Diagnosis of "radio-carpal synovitis."

Anterior straight splint with eversion of hand.

The swelling persisted for about one week, during which there was considerable pain, especially at night. Tenderness persisted for three weeks, when the splint

was removed; but on account of recurring pain, reapplied for a week and then removed permanently.

Light massage and passive motion after the third week until the eighth, at which time all symptoms had disappeared with the exception of slight stiffness. At the end of ninth week took up his work, which was largely writing, and Dec. 12, 1896, at the end of the third month, was without symptoms.

At no time during the treatment was there any sign of callus or deformity, and the wrist at present is perfectly normal.

There are three points to which attention is called in connection with this case, as illustrating a type:

(1.) The sharp localization of all symptoms to that portion of the wrist between the radius and the scaphoid.

(2.) The absence of any objective sign of fractures.

(3.) The long duration of symptoms and disability.

Sir Ashley Cooper and others have demonstrated "that it requires a much less degree of force to fracture the radius than to displace the ulna or to rupture any of its connecting ligaments." While I have been unable clinically to locate the injury in these cases, I have no doubt that in the large majority, if not in all, there is a fracture, probably of the radius; either a fissure or fracture of the extreme tip of the styloid process, in which the distal fragment is so small as to be unrecognized.

The third class is that of sprain of the wrist-joint, and requires very little description.

In this class the diagnosis is comparatively simple, and the duration of symptoms usually much shorter than in either of the other two.

Ten consecutive cases in each of these classes were taken; the diagnosis, if there was the slightest question, was made under ether, and all were treated in the same way. The treatment consisted in the use of a flat anterior splint, made from ordinary "splint-wood," the hand being everted about twenty degrees. Splints were padded with cotton and covered with cotton cloth. Small pads of cotton cloth were used to hold fragments in position and bring pressure locally where needed. Splints at first extended from finger

tips nearly to the elbow, and were later shortened to the middle of palm. Splints were retained until practically all tenderness had disappeared, and until fragments, if they existed, were held in satisfactory position. When the splints had been removed all cases were treated by massage until either all functions had been restored, or the patient failed to appear.

The patients were all men, between twenty and fifty years of age, and in fairly good general condition. As nearly all of these cases were treated in the "Surgical Out-patient Department," it was impracticable to obtain either the ultimate results or the entire period of disability. In the following tables three questions will be considered:

Table 1. Gives the day upon which the acute pain ceased.

Table 2. Gives the day upon which the splint was permanently removed.

Table 3. Gives the day when all cases had reached the same stage in convalescence, when total disability ceased.

The day mentioned, dates from that on which treatment began, and not from the day of the accident, which in most cases preceded treatment from one to three days.

Table I.

Colles' fractures..	3	1	4	2	5	2	3	1	3	3	Average $2\frac{7}{10}$ days
Radio-carpal synovitis	5	4	5	4	2	3	3	4	1	6	Average $3\frac{5}{10}$ days
Sprain	3	4	2	1	3	3	3	2	2	3	Average $2\frac{6}{10}$ days

Table II.

Colles' fractures..	21	33	27	26	16	30	27	28	23	24	Average $25\frac{5}{10}$ days
Radio-carpal synovitis	23	24	28	12	21	26	22	22	20	19	Average $21\frac{7}{10}$ days
Sprain	8	15	20	9	12	8	13	7	14	7	Average $11\frac{3}{10}$ days

TABLE III.

Colles' fractures..	64	70	58	45	33	62	54	40	50	38	Average 51 $\frac{1}{10}$ days
Radio-carpal synovitis	35	60	53	48	38	36	28	35	34	30	Average 39 $\frac{7}{10}$ days
Sprain	12	20	24	16	19	13	20	15	18	10	Average 16 $\frac{7}{10}$ days

It will be seen by reference to the above tables that the acute stages of "radio-carpal synovitis" approach more nearly those of Colles' fracture than they do similar stages of sprain. In Tables 2. and 3. it occupies more nearly a middle ground, while in Table 1 the duration of acute pain is longer than in either sprain or fracture.

While the number of cases of so-called "radio-carpal synovitis" which I have been able to follow to their ultimate result is too small to tabulate, they have in each instance made a rapid improvement after reaching the stage noted in Table 3, and have within a few days returned to the normal. In no case has there been prolonged disability or any deformity.

CONCLUSION.

All cases of injury to the radial side of the wrist-joint should be treated as fractures.

There is a class of cases in which no physical sign of fracture may be determined clinically, but in which the duration of the acute stage and the subjective symptoms approach nearly to those of fracture.

While these cases may not be accurately diagnosticated as fractures, they probably are such, should be treated as such, and the prognosis, as to the duration of disability, should be given accordingly.

XXIII.

OLD DISLOCATION OF THE HUMERUS.

By J. B. Blake, M.D.

The following case occurred in the service of Dr. Burrell, and seemed of sufficient interest to warrant detailed report.

A healthy Italian, twenty-five years old, a laborer, entered the Boston City Hospital on Dec. 30, 1895, presenting a typical sub-coracoid dislocation of the right humerus. Seven months previously he had fallen from a railroad car, striking the right shoulder, and producing a painful injury. He did not consult a physician, but treated himself by the application of camphor liniment. He soon returned to work, in spite of the pain, but was obliged to discontinue it on account of limitation of motion, and for this reason he came to the hospital. History of other injury to this shoulder was not obtainable.

The man was well developed and very muscular. Under ether the diagnosis was obvious. Motion was about one-half normal, circumduction perhaps a trifle more, but rotation of the humerus extremely limited. The elbow could not be approximated to the side. Muscular atrophy and symptoms of pressure on the nerves were not present. The condition of the glenoid cavity could not be determined.

The patient was placed upon his back on an operating table, and a loosely folded sheet fastened, by a clove hitch, about the lower end of the upper arm. A second sheet, smoothly folded, was passed transversely around the body high up in the axilla, holding the axillary border of the scapula firmly against the chest wall. A third sheet was passed under the second, and over the shoulder, snugly against the acromion. See Fig 1. Two assistants were detailed to each sheet, and traction was begun upon the sheet attached to the arm at right angles to the body,

counter-pressure being exerted upon the second and third sheets. After a few moments this traction was suspended, and Dr. Burrell grasped the arm firmly by the condyles

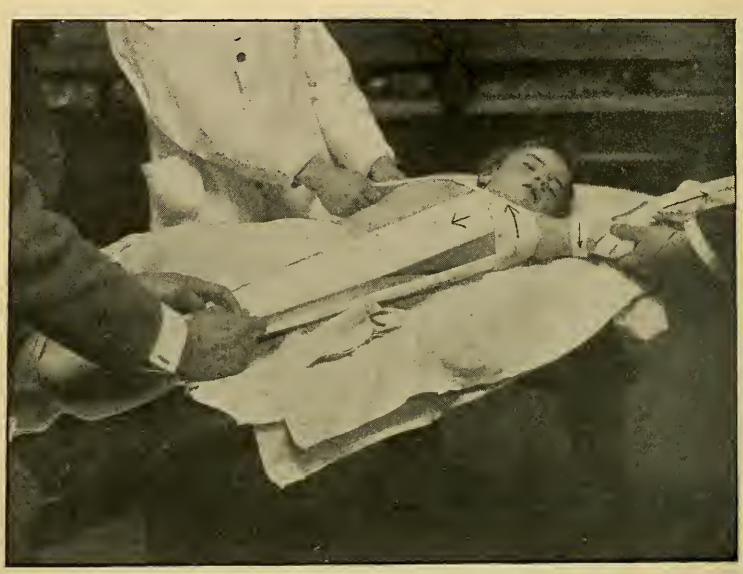

Fig. 1.

of the humerus. Longitudinal rotation of the humerus was then attempted, and after vigorous efforts was gradually accomplished, the tough adhesions about the head of the humerus yielded slowly, and could be felt to give way. Traction was then begun again and the arm gradually swung upwards towards the head, in complete extension. The head of the humerus finally began to slip into place, and the arm was brought down towards the side, counter-pressure being made in the axilla, and after fifteen minutes the head of the humerus was found to have resumed its normal position. This was verified by several surgeons present. The arm was put in a Velpeau bandage with a large pad in the axilla. For two or three days there was considerable pain, and the patient once or twice tore the bandage off, without apparently affecting the position of the bone. Three weeks after operation the dressing was removed, and the position was found to be excellent. A week later a little motion

was permitted. Six weeks after the operation the patient was allowed to move his arm freely and could place his hand on top of the head. He was discharged Feb. 14, 1896.

The patient returns for examination on Feb. 23, 1897. He is in good health, and able to do his work perfectly. Subjective symptoms are not present. Motion is normal except that right arm cannot be extended directly upward quite so completely as the left arm. There is a slight thickening over the anterior aspect of the shoulder-joint, which may perhaps be in the substance of the deltoid. Except for this there is perfect symmetry of the shoulders. Patient says that the arm is as good as ever.

The essential points in the case seem to have been the intelligent application of an unusual amount of force in an accurate manner, and by a logical sequence of motions. The careful adjustment of the folded sheets completely immobilized the scapula, and the applied traction, extension, and rotation acted exactly upon the point they were intended to affect, and were not dissipated upon the surrounding tissues. The case proves that certain dislocations of very long standing may be successfully attacked by a non-operative procedure.

XXIV.

THE TREATMENT OF OLD DISLOCATIONS OF THE SHOULDER.

By F. B. Lund, M.D.

The number of old dislocations of the shoulder which present themselves for treatment at surgical clinics is fortunately becoming smaller from year to year. Thanks to the wide publication of the work of Kocher and others on recent dislocations and their reduction, by far the greater number of dislocations are reduced as soon as seen by the surgeon or general practitioner. Notwithstanding this fact, however, a certain number of patients with old dislocations present themselves at the clinics, some of whom have never previously consulted a surgeon, and a few who have been unfortunate in their choice of a surgical adviser. By the personal observation of a few of those which I have been kindly allowed to examine by members of the visiting staff at the Boston City Hospital, and by personal experience of some of the difficulties of their reduction, I was led to look up the question of their treatment, and see what light, if any, could be thrown upon it by an examination of the literature of the subject and of the hospital records. The result, though not entirely satisfactory, owing perhaps to the small experience in the treatment of these cases which comes to any one man and the resulting meagreness of the literature of the subject, has nevertheless been that certain interesting and important points with reference to the treatment of these injuries have been brought out.

In the first place, as is well known, the difficulty of reducing dislocations of the shoulder, after the lapse of a very short period, say two weeks, increases directly in propor-

tion to the interval of time. Dislocations of less than two weeks' duration are almost as easy to reduce as fresh dislocations; and since Kocher has shown that all fresh, uncomplicated dislocations are reducible by manipulative methods, all dislocations two weeks old or less, are capable of reduction by methods of manipulation. The same anatomical characteristics which render the shoulder-joint the most liable to dislocation of any joint in the body in themselves facilitate reduction. It is comparatively easy for the large globular head of the humerus to slip out of the shallow cup of the glenoid cavity, if the necessary rupture of the capsule is present, and the rupture of the capsule made by the head of the humerus is always big enough to let the head slip back, if it is properly opened by Kocher's or other methods of manipulation. The free play of the head of the bone under the arch of the acromion, the comparative looseness of the capsule, all render dislocation and reduction comparatively easy. The tendons of most of the muscles about the joint are short, and so intimately blended with the capsule as not to afford obstacles to reduction by slipping in between the head of the bone and the socket. Even the long tendon of the biceps, which at first thought one would suppose most likely to fall in between the head and the socket, so as to prevent reduction, is held up out of the way by its special fibrous channel in the capsule of the joint, from which, in the ordinary subcoracoid dislocation, it is never displaced.

The manipulative methods for reduction of the shoulder-joint, especially the simple, beautiful, and efficient method devised by Kocher, of Berne, are too well known to need discussion here. Suffice it to say that Kocher's method is to be preferred in all fresh dislocations, as being the simplest and easiest, as requiring no direct pressure on the axillary vessels and nerves, and as being successful in a large proportion of cases without anesthesia.

Dislocations of the shoulder a week or less old, then, should be reduced in all cases, preferably by Kocher's method.

After the head of the humerus has been out under the coracoid process for two weeks or more, however, difficulties

in the way of reduction begin to present themselves. The unruptured posterior portion of the capsule, which has been tightly stretched across the glenoid cavity, has become in old cases rather firmly adherent to that cavity. The head of the humerus has become adherent as it lies nipped between the biceps and coraco-brachialis muscles and the neck of the scapula. The posterior rotators of the humerus, the supra-spinatus, infra-spinatus, and teres minor muscles have become so paralyzed by continued stretching as to no longer afford efficient aid to the surgeon in pulling the head of the bone back into place. In order to successfully reduce the dislocation, the head of the humerus must be freed from the adhesions which bind it into its new position, the adherent capsule must be peeled off from the surface of the glenoid cavity, and the head of the humerus forced back under the acromion, lifting the adherent capsule and the tendons of the posterior rotators out of the way. After a still longer time, say two or three months, has elapsed, the neck of the humerus has become fixed under the coracoid by firm fibrous adhesions, the capsule has become so firmly bound down to the glenoid cup as to actually form a part of it, and the atrophy of the deltoid and posterior scapular muscles bears witness to the fact that even if the dislocation should be reduced, these muscles would require a long course of training in order to recover strength enough to hold the head of the humerus up in place in its socket. The important part played by these muscles in holding the head of the bone in place is shown by the subluxation of the head of the bone, which takes place when they have become paralyzed. In paralysis of the deltoid and scapular group without dislocation we have seen the head of the humerus fall downward and forward out of its socket, within the loose capsule of course, to such an extent that the head got over the anterior edge of the glenoid, the arm was lengthened nearly an inch, and this, together with the flattened deltoid, gave a typical picture of a dislocation. By grasping the humerus, however, the head of the bone could be easily lifted into position, but the paralyzed muscle could not hold it.

Now with regard to this adhesion of the posterior portion of the capsule to the glenoid cup. The capsule, of course,

is more or less thickened by the inflammatory processes, and fills up the cavity, adhering over its broad surface, so that it cannot be stripped off. It is in this class of cases that we read in the records, that the head was almost reduced, but could not quite be made to get into perfect position; that it remained just on the edge of the glenoid: that although something had been gained, reduction could not be considered quite satisfactory. What has happened in these cases is in all probability this: that since the efforts at forcing the head back into place fail to strip the adherent capsule off the surface of the glenoid, the capsule, by the violent efforts at reduction, is ruptured opposite the anterior edge of the glenoid, and the head forced back over the glenoid is kept out of its socket by the part still adherent. Unless that adherent capsule be peeled off, the complete and satisfactory reduction of the head of the bone will be, and is, impossible. The question suggests itself, Why not open the joint in these cases by operation, and peel off the capsule, or gouge it out so as practically to make a new socket, by a method analogous to Hoffa's operation in congenital dislocation of the hip, so as to allow complete reduction of the dislocation? The answer to this query opens up the wide question of operative reduction of dislocations of the shoulder, which will be considered later on.

With reference to the obstacles to reduction in cases of old dislocations of the shoulder, I may refer to Kocher's article in the "*Deutsche Zeitschrift für Chirurgie*," 1890, p. 423, in which we find the details of his findings at operation or autopsy on eight cases ranging in age from five weeks to eleven months. In some cases the capsule was adherent to the glenoid, as described above, in others the rent in the capsule had healed so completely behind the head of the bone as to prevent reduction. In seven of the eight cases the great tuberosity had been pulled off, and in several, portions of the capsule were greatly thickened and at times calcified. The glenoid cavity was sometimes filled up with a thick, rough deposit of bone. The head of the humerus had in one case of six months' standing formed for itself a new socket in the front of the neck of the scapula. The familiar picture of such a socket upon a scapula from a case

of Sir Astley Cooper's, figured in Stimson's and Hamilton's works on fractures and dislocations, you will, doubtless, most of you remember. An interesting fact about this case is that in one it is classed among subcoracoid and in the other among subglenoid dislocations.

Such being the pathological conditions found in cases of old dislocations of the humerus, what is to be our method of procedure in attempting reductions? In order to answer this question intelligently we must consider the relation of the danger attending attempts at reduction to the severity of the symptoms which we are endeavoring to relieve, the prospect of successful reduction, and the advantages gained thereby.

What are the symptoms for which our patients apply to us for relief? In the first place, we find that these old dislocations of the shoulder present a very different picture from the fresh dislocations. The atrophy of the deltoid and scapular muscles allows the bony landmarks to stand out in bold relief, and the diagnosis is so easy as to admit of no doubt whatever. The elbow is not held away from the side as in fresh dislocations, as the deltoid has been stretched sufficiently to allow it to fall easily in. Rotation of the head of the humerus is absent or nearly so, abduction of the arm is possible only by elevation of the scapula, and very rarely can be carried to a right angle. Forward elevation is possible to a right angle, and backward not at all. All motions of the forearm, elbow, and hand are normal. The patient can do light work, fetch and carry, but is usually unfitted for the heavy work of a laborer.

The above picture is doubtless recognized to be more favorable than certain cases which we have all of us seen, in which pain, œdema, paralysis, etc., from pressure of the head of the bone upon the brachial plexus, are present; but it is proposed in this discussion to deal with the average cases. Cases in which the latter symptoms are present require, of course, more heroic treatment.

Old cases are also occasionally seen in which such excellent motion of the arm has been obtained that the hand can be easily placed on the head, and almost all movements performed with ease. Such a case has been recently seen

by the writer at the Boston City Hospital, in the service of Dr. H. W. Cushing.

In the treatment of these cases, manipulative methods, as the simplest and least radical, will, of course, first be tried, and the question be considered as to what manipulative methods combine the greatest effectiveness with the least danger. And the danger in these cases is of two sorts: first, fracture of the humerus, not a very uncommon accident; and a second and much more serious mishap, rupture of the brachial artery or vein. This accident happened to no less eminent and careful a surgeon than Sir Joseph Lister, who tied the artery, but lost his patient from shock. The autopsy in his case showed, in the first place, atheroma of the vessel, a finding which should make us cautious in the application of violent manipulative methods in aged patients, and also revealed beautifully the mechanism by which the injury took place. Although the attempt was made only eight weeks after the dislocation, at the autopsy was found a "strong fibroserous band, connecting the head of the humerus with the coracoid process, and intimately blended by condensed tissue with the sheath of the axillary artery, which lay directly over it." Strong traction made upon this band was necessarily communicated to the axillary artery, which had a small hole torn in its side. This autopsy is of interest, as showing that rupture of the artery is more likely to take place from traction upon fibrous bands, which is essential to all manipulative methods of reducing dislocations of the humerus, rather than from pressure, as over a pad or heel in the axilla, which pressure if properly applied ought to be behind the artery rather than directly upon it. Although but few cases of rupture of the axillary artery in attempts to reduce dislocations of the shoulder have been published, most surgeons of experience have either seen such cases or heard of them. Violent manipulations should then be avoided in old patients or those with atheromatous arteries.

Stimson[1] reported 44 cases of rupture of the axillary artery or vein obtained from the literature of the subject up to that date. In more than half the cases the dislocation had

[1] Annals of Surgery, 1885.

existed less than three weeks. In not more than a third of them was it reasonably certain that the injury was caused by the attempts at reduction and not by the dislocation itself. The danger of the accident is attested by the fact that only 12 of the 44 cases recovered, 31 died, and in 1 the result was not known. Of 20 cases not operated upon, 6 recovered and 14 died. Of 14 in which the subclavian was tied, 5 recovered and 8 died; 6 cases in which an incision was made in the axilla and the artery tied above and below the wound died. Of 4 in which the limb was disarticulated, 1 recovered and 3 died.

In order to avoid these dangers, Kocher in his article above referred to advocated the application in these cases of his own method for the reduction of fresh dislocations, slightly modified to meet the requirements arising from the adhesions and other changes present in old dislocations. These modifications consisted chiefly in that the manipulations should be made more slowly, that the elbow should be carried in the first movement a little back of the mid-axillary line instead of directly to the side, that the arm should be held for some time in complete outward rotation, and that during the third movement, lifting the elbow in the sagittal plane, a pad might be placed in the axilla to act as a fulcrum in prying the head of the bone outward into position. Kocher has found this method successful in reducing 25 out of 28 old dislocations, 3 of them being over four months old. He had fractured the humerus, however, in 3 cases, a rather large proportion.

The advocacy of this method in old dislocations by so great an authority as Kocher has led to its extensive trial, and in other hands it has apparently not met with such good success. I think it can be shown that this method in reality is attended with great danger of fracture of the humerus. The liability of the humerus to fracture under twisting strains has been shown by Monks;[1] and the second movement of Kocher's method, extreme outward rotation, the forearm at right angles and used as a lever, exposes the humerus, if its head is firmly held by adhesions, to a twisting strain of extreme severity.

[1] Boston Medical and Surgical Journal, Jan. 9, 1895, and March 21, 1896.

Morton [1] reports three cases in which this accident has happened in the attempt to reduce old dislocations by the Kocher method. In his own case the fracture, which was "very oblique through the head and neck of the bone" (probably a spiral fracture), occurred just as the arm, after being completely rotated outward, had been raised to the termination of the third movement across the chest. Here we have twisting strain combined with leverage, a very dangerous combination, if the head of the bone is firmly held by adhesions. The occurrence of at least one other case in which fracture resulted from the employment of this method is known to the writer. As Morton suggests, it is unwise to employ this method in old dislocations unless manipulations have previously been employed to rupture as far as possible the adhesions which hold the head of the humerus in its new position.

Now what manipulations are the safest and most efficient to employ in breaking up adhesions between the head and neck of the humerus and the scapula? It is self-evident that we must first fix the scapula, before we attempt to move the humerus on it, whatever method we adopt, else the whole shoulder girdle will follow the excursions of the humerus, and no motion between the scapula and the latter will take place. In the reduction of fresh dislocations by Kocher's method, without anesthesia, the scapula is beautifully fixed by involuntary spasm of the muscles, the edge of the glenoid being firmly held as a fulcrum for the motions of the head of the bone. In these old dislocations, however, we will find it necessary to resort to anesthesia in almost all cases, and must find some artificial means of fixing the scapula. This is done rather efficiently by the surgeon's heel as it is forced into the axilla, Sir Astley Cooper's method, a method which the writer has found efficient in reducing one case of old dislocation, and may be accomplished, though rather inefficiently, by the hands of an assistant embracing the trunk of a patient from the opposite side, and clasped over the scapula. The most efficient method, and one which was successful in the remarkable case of Dr. Burrell, is that of passing folded sheets over the shoulder

[1] Philadelphia Polyclinic, Dec. 15, 1894.

and around the body, these sheets being held by assistants. The full description of this case is found on pages 367–9 of this report. Rapid and forcible rotation of the humerus back and forth, within short limits at first and gradually increasing, is probably the safest method of breaking up adhesions. In performing this rotation the forearm should not be used as a lever.

Extension of the arm above a right angle to the body stretches the axillary vessels and brachial plexus across the head of the humerus, and is attended with danger of injuring them. It should therefore be avoided.

All manipulative methods in old cases require the application of considerable force. The amount of force which it is safe to apply must be left in each individual case to the judgment of the surgeon. Atheroma of arteries and firm adhesions in aged patients contra-indicate great force. In young patients a very considerable degree of force, if carefully and intelligently carried out, may be safely employed. Dr. Burrell's successful reduction after eight months, it will be remembered, was in the case of a muscular man twenty-three years of age. The probability of success in these cases decreases directly with the length of time since the accident happened.

We are now confronted by the question: If manipulative methods fail, shall operative methods be resorted to for reduction? In order to answer this question intelligently we must consider, first, the extent of the disability which we are attempting to relieve; second, how much good will probably result from operative measures; and third, what the danger of such methods is, and their prospect of success.

The first question we have already answered before considering manipulative methods and their dangers.

The second can only be answered by a brief consideration of the various operative methods in turn.

The methods which have been proposed for the operative treatment of old dislocations of the shoulder are, first, osteotomy of the surgical neck, with formation of a false joint (Mears[1]); second, subcutaneous section of the capsule and

[1] Philadelphia Medical and Surgical Reporter, Oct. 13, 1877.

reduction (Pollaillon[1]); third, reduction by open incision: fourth, resection of the head of the humerus.

The subcutaneous section of the neck of the humerus has failed to show good results. The subcutaneous section of the capsule is a survival of preantiseptic methods. The blind section of the adhesions about the head of the humerus is manifestly attended with great danger of wounding arteries and nerves, and the open incision is manifestly simpler, easier, and safer. The reduction by open incision and the resection of the head of the humerus remain as the only methods worthy of serious consideration.

Reduction by open incision was first performed by Wattman, of Innsbrück,[2] in 1820. He succeeded in effecting reduction, but (strange to say!) suppuration followed, but healing finally took place, and the patient left the hospital (time not stated), having still great limitation of motion.

The introduction of antiseptic methods naturally encouraged further attempts of the sort; and in 1888 Knapp published a report of 12 cases, of which 2 died, 1 of sepsis and the other of delirium tremens. Of the remaining 10, 1 attempt resulted in fracture of the surgical neck with pseudarthrosis, 3 in necrosis of the head of the humerus, necessitating subsequent extraction; in 2 the reports were incomplete; and in the remaining 4 material functional improvement resulted. Surely not a very brilliant showing for the operation. Of operations by resection of the head of the humerus he had collected 20 cases, of which 4 were fatal. Of the remaining 16, the later reports were inadequate in 6, leaving 10 cases in which the results were in part equal to those of arthrotomy, and in part decidedly better.

The results of Kocher's experience with bloody reposition, published in 1890,[3] are scarcely more reassuring. Of 8 cases on which he operated he found only 1 to be uncomplicated by fracture of the tuberosities or the glenoid rim. In 6 bloody reposition was done, and in 2 of these was final improvement in the use of the arm noted. One

[1] Bull. de la Soc. de Chir., 22 Fevrier, 1882.

[2] Knapp: Bruns' Beiträge zur klin. Chir., 1888, 4, 372.

[3] Loc. cit.

died of sepsis. Of 2 resections of the humeral head 1 gave a good functional result.

Both bloody reposition and resection of the humeral head have, according to the showing of these two writers, not given results sufficiently brilliant to encourage their general adoption. Resection of the humeral head has, however, the advantage that it can be successfully carried out in cases where, owing to the filling up of the joint cavity or other causes, bloody reposition is unsuccessful.

We cannot leave the question in 1896, however, exactly where it was in 1890; and let us now see what has been accomplished in our field since that date. The gloomy showing given above naturally failed to encourage many surgeons to attempt operative relief in shoulder dislocations, but a certain number of cases have presented themselves for treatment in which any slight prospect of improvement was to be preferred to the present pitiable condition of the patient, and in which operative relief has been undertaken. Such cases are those in which pressure of the humeral head upon the axillary vessels and nerves has resulted in unbearable pain and swelling of the arm, and two cases in which the patient was rendered absolutely helpless by a double irreducible dislocation. I think it will appear that the results of these more recent operations have been more satisfactory than those of the earlier cases reported by Kocher and Knapp.

A. Pearce Gould[1] reports a case in which he performed reduction by open incision upon a dislocation of fourteen months' standing, after manipulative methods had failed. "After nine months rotation of the shoulder was nearly perfect, and all the usual movements could be performed." The man was able to perform severe and continuous manual labor, the only injury remaining being some disability of the hand, due to damage to the ulnar nerve.

Watson Cheyne[2] showed a case upon which a similar operation had been performed in a dislocation of four months' standing. The result was less satisfactory than in the preceding case, but the man was enabled to do his work as a French polisher.

[1] British Medical Journal, Feb. 27, 1892. [2] Loc. cit.

Sir Joseph Lister[1] had the rare good fortune of operating successfully on two cases of double irreducible dislocation of the shoulder. The propriety of any operative attempts at relief of such cases as these can hardly be questioned. In the second case the man was unable to put either hand to the gluteal region; the pitiable dependence resulting from which condition is obvious.

In Lister's first case, a robust laborer of forty-seven, with a double dislocation of four months' standing, bloody reposition was done upon each shoulder at a separate operation. The result was complete recovery of every motion of the shoulder except ability to lift the arm above a horizontal level, ability to perform hard manual labor, and recovery of the full size of the deltoid muscle. In the second case, that of an epileptic, both of whose shoulders had been dislocated for seven months, two operations were also done, with the result that the man was enabled to earn his living on a farm, and to perform very hard manual labor.

Polosson[2] reports five cases of arthrotomy and reduction of old dislocation, in three of which good functional results were obtained. In one suppuration necessitated subsequent resection of the head of humerus, and in one death resulted from the operation.

MacCormac[3] reports a case in which arthrotomy had to be followed by resection on account of suppuration.

Owen[4] reports a case of resection for old dislocation.

Monks[5] reports a case of resection of the head of the humerus in a case of old dislocation attended by pain, atrophy of the muscles, and swelling of the arm from pressure on the nerves and vessels, in which the operation gave an excellent result.

Delbet[6] reports a case of resection of the head of the humerus for an old dislocation in which attempts at reduction by arthrotomy by a posterior incision had been unsuccessful.

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[1] Loc. cit.

[2] Assoc. Franc. de Chir. Proc. Verb., Paris, 1893, vii. pp. 384 to 388.

[3] Loc. cit.

[4] Clinical Journal, London, 1894, iii. pp. 273, 277.

[5] Medical and Surgical Report, Boston City Hospital, 1895, and Boston Medical and Surgical Journal, April 30, 1896.

[6] Arch. Gén. de Méd., Paris, 1893, t. 19, 144.

The functional result of the operation was excellent. As a result of this experience he condemns the posterior incision, which he had been led to attempt by the results of experiment upon the cadaver. In his paper he gives a list of the reported cases of arthrotomy and resection, showing that there had been up to that time 28 arthrotomies reported, 3 of which died, a mortality of 10.72 per cent. Of 34 resections 5 had died, a mortality of 14.36 per cent. Although the mortality of resection is a little higher, the number of cases is too small and extends over too long a time to be of much value for purposes of comparison.

Arthrotomy would seem to be a more difficult operation than resection, and it is a little surprising that the latter should show a higher mortality. Of the 25 cases which recovered from the operation by arthrotomy, the results were good or fairly good in 12 : 5 results were poor. In 4 secondary resection had to be done, and in 3 results were unknown. In 1 the attempt resulted in fracture of the humerus and subsequent pseudarthrosis.

Polosson's results are not included in the statistics of Delbet. If these are added, we have 33 cases, with 15 good results, 6 poor results, 5 secondary resections, 4 deaths, and 3 cases not heard from ; mortality, 9.1 per cent.

Collecting the cases since 1890, we find arthrotomy as follows :

Gould, 1 case. Result good.

Cheyne, 1 case. Result good.

Lister, 2 cases. Result good.

Polosson, 5 cases. Three results good, 1 poor, 1 death.

MacCormac, 1 case. Result poor.

This gives 10 cases, with 6 good results, 2 poor results, and 1 death. In the 2 cases in which the result was unsatisfactory, secondary resection was performed on account of suppuration.

Of 29 cases which survived the operation for resection, in 13 the results were satisfactory (to these may be added the cases of Monks, MacCormac, and Owen, making 37 cases with 16 good results), in 5 the results were mediocre, in 2 bad, and in 6 the results were unknown. The mortality is reduced to 13.5 per cent.

Schede has stated that the results of arthrotomy with reduction are far preferable to those of resection; but, as Delbet points out, the results are not comparable, and each case must be judged upon its merits. In the large majority of cases the operation is begun with the attempt at reduction, and if this is unsuccessful resection is performed. Resection can be performed secondarily if necrosis of the head of the humerus or long-continued suppuration should follow arthrotomy, and these accidents may be avoided by strict asepsis.

Arthrotomy with reduction should be our ideal, as it more nearly restores the normal conditions of the joint and surrounding structures. It is, however, a very difficult operation, more difficult than resection, and in cases where on opening the joint we find the head of the humerus enlarged by bony new growth, so that it cannot be forced into the glenoid cavity, it must be resected. When the glenoid cavity cannot be satisfactorily opened up so as to receive the head with a fair probability of its staying in place, resection should likewise be done.

It is a question whether, as Delbet says, in cases in which reduction by arthrotomy is attended by great difficulty, so that extensive division of the muscles about the joint is required, and the head of the humerus will be held tightly by firm adhesions when healing has taken place, resection should not be preferred to arthrotomy as a primary measure. In Lister's and Gould's very successful cases, however, the muscles reunited after extensive section, and an excellent functional result was attained, so that they speak strongly in favor of arthrotomy. After resection the power of rotation, which was retained in these cases, will be necessarily lost, as the attachments of the rotators to the tuberosities are removed. If resection is necessary, only so much of the head of the bone should be removed as will enable the operator to slip the upper end into the socket. Too extensive removal gives a loose flail joint; too economical a cut exposes to danger of anchylosis.

I have collected from the records of the Boston City Hospital since 1882 the results of 27 cases which, as will be seen, have been treated by manipulation only, in all except two cases.

The results in these cases are of interest as showing the prospect of success by manipulative methods at different times after the injury, and as showing that after a certain very limited period the dislocation, if reduced at all, must be with rare exceptions reduced by open incision.

Dislocations of two weeks' duration and less are considered as fresh dislocations, and do not enter into our treatment of the subject. Cases in which the note reads, "Reduction fairly successful," or "Head of bone in fair position," have been classed as unsuccessful cases. I found records of four dislocations of from two to three weeks' standing, all of which were reduced successfully by manipulation. Three were reduced by traction downward and outward, with pressure upon the head of the humerus in the axilla. In one case in which the head of the humerus was said to lie under the clavicle which was reduced by extension at right angles to the body, we find it noted that pain in the arm, numbness of the fingers, paralysis of the deltoid with reaction of degeneration, and weakness of other muscles persisted after reduction. This state of things indicated injury to the circumflex nerve, which, as is well known, encircles the neck of the humerus close to the head, and would, it seems, probably be liable to severe stretching in cases where the humeral head moves far inward (subclavicular). The method of extension at or above a right angle to the body is attended with danger of injury to the brachial plexus and axillary artery.

At three weeks two successful cases are reported.

At four weeks two cases are reported in which manipulative methods succeeded.

At five weeks four cases, all successful.

At six weeks two successful cases and one unsuccessful, the latter being a patient of seventy-two years. The patient came into the hospital with œdema of the hand, great limitation of motion, and much pain, and left in the same condition.

At nine weeks one case was not reduced by manipulative methods. The patient was sixty-four years of age, and had fair use of his arm. Manipulation was desisted from, owing to the difficulty and danger of further attempts.

At three months there are two cases in both of which complete reduction was not attained, though the head of the bone was in better position than before operation.

At four months one case is reported, "Head of the bone could not be replaced in the socket."

These cases, as shown by the fact that the head of the bone was freed from adhesions and brought to the edge of the glenoid, but could not be slipped in, illustrate well the effect of the filling up of the glenoid cavity and closure of the rent in the capsule which has been alluded to above.

At five and a half months we find a case reported of a sailor who fell from aloft on shipboard, and in whom several attempts at reduction made at various times had been unsuccessful. In the attempt at reduction, rotation, very moderate in force, was attended by fracture of lower part of body of scapula and fracture of surgical neck of humerus. The danger of rotation, using the forearm as a lever, has been commented upon above.

At six months two cases are found in both of which attempts at reduction were unsuccessful, and in one of which fracture of the surgical neck of the humerus resulted during the attempts.

At eight months one successful and one unsuccessful case are reported, the former being the case of Dr. Burrell alluded to above.

At ten months we find one case in which Dr. George H. Monks resected the head of the humerus for pain, paralysis, and atrophy of the muscles about the shoulder, and of all the muscles supplied by the median and ulnar nerves. The man had absolutely no use of his arm. The operation resulted in great improvement of his condition.

At one year there is one case in which attempts at reduction by manipulation were desisted from on account of fear of fracture.

At one and a half years we have one case in which Dr. Burrell resected the capsule for a recurrent dislocation, on a man of twenty-seven, with good result.

A tabular view of the cases, arranged according to time, follows:

Time.	Cases.	Successful.	Failures.	Remarks.
2 to 3 weeks.....	4	4	0	
3 "	2	2	0	
4 "	2	2	0	
5 "	4	4	0	
6 "	3	2	1	
9 "	1	0	1	
3 months.....	2	0	2	
4 "	1	0	1	
5½ "	1	0	1	Fracture of surgical neck.
6 "	2	0	2	One fracture of surgical neck.
8 "	2	1	1	
10 "	1	0	1	Resection of head of humerus.
12 "	1	0	1	
1½ years	1	0	1	Open incision and resection of capsule.
	27	15	12	

A glance at this table shows that all the cases reduced by manipulation were of six weeks' duration, with one exception — that reduced by Dr. Burrell at eight months.

There were 15 successful cases, 14 of them under six weeks. There was one failure at six weeks.

All the cases over six weeks in duration could not be reduced by manipulation, except in the case above noted. There were thus 12 cases in which manipulation failed, and of these 12 only one was of less than seven weeks' duration. In one of these resection of the head of the humerus was attended by a happy result, and in one, a recurrent case, excision of the capsule was successful.

In two of the unsuccessful cases, one at five and a half and one at six months, fracture of the surgical neck resulted from attempts at reduction by manipulation.

If these cases show anything, it is that after more than six weeks have elapsed such changes have usually taken place as to render success, with such manipulative methods as it is safe to employ without danger of fracture of the humerus or rupture of the axillary artery, improbable.

If reduction is to be effected at all, it must be accomplished by arthrotomy, with or without resection of the head of the humerus. Whether such operative interference should be adopted must be decided upon the merits of each individual case. We must be guided by —

(1) The extent of the present disability.
(2) The amount of pain.
(3) The pressure symptoms.

Where very great disability, involving inability to earn a livelihood, pain, or paralysis from pressure are present, in dislocations of over six weeks' standing and in patients who are in good condition to bear operation, operative relief should be considered, although both operations are of such severity that the question of their performance must be carefully weighed in each case.

The results of arthrotomy and resection in the last six years give us somewhat greater hope of affording relief to our patients by their employment than those reported in Kocher's and Bruns' papers.

The mortality of operative procedures will probably be low if cases in which senile or other constitutional defects render operation dangerous are rigidly excluded, and if in cases where arthrotomy is attempted, and the conditions found point to a difficult and tedious operation, prompt resection is performed.

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XXV.

SIMPLE AND SATISFACTORY BANDAGE FOR ACUTE FLEXION OF THE ELBOW JOINT.

By F. B. Lund, M.D.

The method first established on experimental and clinical grounds by Smith, at the Boston City Hospital, of acute flexion in the treatment of fractures of the lower end of the

Fig. 1.

humerus, has found increased favor at that and other institutions, as additional experience has further demonstrated its value. The internal rectangular splint has fallen into disuse, and acute flexion without splints become the rule in these fractures, except in special cases.

Fig. 2.

The method of bandaging the arm in acute flexion, suggested by Smith, namely, a strip of adhesive plaster about the wrist and upper arm, though efficient, has been found uncomfortable, as the edges of the plaster cut into the skin.

The method of sewing up the arm in a modified sling,

which is employed at the hospital, is comfortable, but requires time to adjust, and is not absolutely efficient in maintaining acute flexion.

In attempting to devise an efficient bandage which could be quickly applied in out-patient practice, I hit upon a method which has given such satisfaction in my own and other hands that I venture to describe it.

A cotton swathe of the width of the shoulder, and long enough to make a figure of 8 around the elbow and body is passed under the flexed elbow, horizontally, its centre being at the point of the elbow. The proximal end is carried snugly up around the forearm and over the shoulder, and the distal brought forward around the arm, across the front of the chest, and under the opposite arm. It is pinned to the end which has been brought over the shoulder, behind the back of the patient.

By tension upon the ends of the bandage, the flexion of the arm can be carried to any desired degree, and efforts of the patient to extricate the arm only serve to tighten the swathe. The pressure is distributed along the whole length of the arm and forearm, so that no injurious local pressure is created.

The advantages of this bandage in efficiency, comfort, and ease of application have led me to employ it in all cases where acute flexion of the elbow is to be maintained.

A glance at the figures will illustrate the method of application.

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